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An Introductory Research Course

• By Jay A. Young, Ph.D., *(University of Notre Dame)*
DEPARTMENT OF CHEMISTRY, KING'S COLLEGE, WILKES-BARRE, PENNSYLVANIA

This stimulating paper describes the aims and conduct of a successful undergraduate introductory course in research in chemistry. It is an encouraging report of progress, pointing out the difficulties as well as the successes encountered during its first year of operation.

Readers will agree that those who complete such a course will "have something" that other students frequently lack.

This paper was presented at a recent meeting of the Pennsylvania Catholic Round Table of Science, held at Mount Mercy College, Pittsburgh.

For the most part, we teachers are pretty busy from September to June and have little time to improve our stature by studying, by playing with research problems, or by just going off in a corner and thinking. However, most of us do have at least a few weeks or so in the late summer when we can call our time our own.

Last summer I spent some of this free time browsing through the last fifteen years of the *Journal of Chemical Education*, a practice I recommend highly. I obtained several fruitful ideas. One of these was contained in three articles (1), (2), (3), on the subject of undergraduate research. Fired with an enthusiasm which has since increased, we decided to offer our own introductory research course. This paper presents a summary of our views and conclusions after the experience of one school year's attempt to teach an undergraduate "all about research."

At this writing, five senior chemistry majors have almost fulfilled the rather vague requirements for this course. As specifically as it can be stated, our purpose in offering this course is fourfold: To learn that it is a tedious, time consuming, and often frustrating task to get a fact from Nature; to learn a little of the meaning of the word "research" by actual experience; to cultivate in the student something that might be called the first glimmer of the scientific spirit; and to accomplish something scientifically valuable, whenever possible.

We have not met with complete success in attaining our fourfold end; however, the ends have been met sufficiently well to warrant our continuing the course in the future. Each man has certainly found that it requires hard work to wrest a fact from his apparatus and chemicals. They have learned to ask a question, i.e., state their problem, in a formal manner and then work out a logical plan to determine the answer; certainly they are much better equipped now to tackle their next research problem in industry or in graduate school. We did fail almost completely to obtain any scientifically valuable results. No student completed his problem and this was, of course, disappointing to the men. But judging from their remarks, they were not pessimistically disappointed; in fact, each man wrote his thesis in a hopeful manner, indicating to the future student reader that all the spade work has been done and it only remains for the next student to put together all that they have collected.

Originally, it was planned to admit only the better students to this course. However, a student with average ability applied for admission and was accepted. As it turned out, the poorer student got more from the course than his classmates. Although his work was perhaps not equal in all respects to that of the others, it was certainly satisfactory. If this course were to be restricted to a certain class of students, it would be better to admit only those from the lower half of the class. Fortunately, we have sufficient facilities here to admit all who elect to take the course.

The projects chosen by the students were selected from a long list of suggestions gleaned from various sources: personal research interests, articles in the technical journals describing original research work, and articles in the review journals. I regret to report that no one chose one of my own pet problems . . . perhaps next year?

This year we studied: The construction of a source of ultra-violet light for future use in photo-chemical studies; a repetition of the Franck-Hertz experiment on ionization potential; the construction of an AC Wheatstone Bridge for use in a future study of conductance phenomena; and an investigation of the "mercury heart." (When a globule of mercury, covered with an acidified solution of potassium permanganate, is lightly touched with a steel needle, it begins to pulsate—giving rise to the name, "mercury heart.")

Each student is required to spend a minimum of eight hours a week in the library, studying references pertaining to his problem, and/or in the laboratory, working on the problem itself. For this he receives three hours credit. We found it very helpful, at the start of the second semester, to assign definite days and time for this work. During the first semester, the requirements were more or less informal, with the result that insufficient work was performed.

Along toward the end of the school year, the student prepared an outline of his "thesis." After approval of the outline a first draft of the thesis was submitted. We found that the third or fourth draft of the thesis was acceptable. To help them get started, they were given a general outline to follow: A, *Introduction* (Why the problem was undertaken. Background information on work done by others.); B, *State-*

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The Saint Louis University Institute For the Teaching of Chemistry

• **By Barbara Callahan**
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It is the rule, rather than the exception, that the graduates of chemistry who select teaching as their profession, find that their college work did not prepare them adequately for the difficult and responsible task of teaching this strange science to the young. Some are never aware of their deficiencies, but others who find themselves frustrated in their efforts to present their subject to students, look about for means of self-improvement.

Saint Louis University is one of the schools which has come to their aid by the establishment of its Institute for the Teaching of Chemistry in 1950.

The enthusiasm with which teachers of chemistry have received the Institute and the interest they show as students in the Institute would attest to the success of the program.

•

Today America is leading the world in all fields of science. Never have the contributions of science, particularly chemistry, been felt so effectively in all phases of society as in this 20th century. There is virtually nothing one does, nothing one eats, wears, or even touches in which chemistry has not played some part. New discoveries have opened up entire new fields of specialties for the professional chemist to follow. Impressed by the success of chemistry the average layman has developed an interest in how, through chemistry, there will continue to be "better things for better living."

The importance which chemistry has assumed has created two implications: first, the schools and universities must train specialists to carry on the work; and secondly, there must be teachers to teach the general public the meaning of chemistry.

Our schools and universities have done an excellent job in solving the first problem. But up to this time, little has been done to train the teachers of chemistry, whose job is not only to train professional chemists but to impart to the general student an understanding of science, the aims and principles of the scientists, and to satisfy, in some small way, at least, the curiosity which necessarily follows the changes in the way of life through science. Training teachers has been largely left to departments of education and to related departments. This leaves to chance the problem of correlation in the training of the teacher, and also leaves undeveloped the area of courses designed specifically for chemistry teachers.

In recognition of this problem, and to meet the need for a program to train those who plan to teach chemistry, St. Louis University established the Institute for the Teaching of Chemistry. By cooperating with and utilizing the facilities of the University which may contribute to the training, the Institute is trying to give to the future teacher the training necessary for the "ideal chemistry teacher."

Throughout the entire Institute, St. Louis University has as its primary objective the formulation of the true and perfect Christian in his wholeness. The philosophy is briefly as follows: "As each agency of the Church for human welfare and progress has its distinctive area of emphasis, so the college in Catholic thinking exists to impart knowledge considered essential to a liberal education; to provide experience designed to cultivate the intellect, will, and emotions; to produce, in fine, the educated man possessed of broad knowledge, a trained mind, and intellectual Catholicism, and an operative Christian philosophy of life."

The "ideal chemistry teacher," the University believes, must meet the following justifications: He understands well the field of chemical science and keeps up with its development; he knows the basic relations of chemistry to the other sciences, and to the whole of human knowledge; he understands the various conceptions of the goals of education and the process of education; and he is a master of the techniques of the art of teaching.

In order to train the ideal chemistry teacher, there are three aspects to the Institute's program. The first is the undergraduate program leading to the Bachelor of Science in the Teaching of Chemistry degree. This degree combines a chemistry major with an education minor which is designed to meet the teaching requirements of most states, and which, with proper modification, can be adjusted to meet the requirements of all states. The second is the graduate program leading to the Master of Science in the Teaching of Chemistry, designed for those who wish to secure the best possible background training for their job of teaching chemistry on the high school level. Third is the Summer Program of the Institute, which is part of the Master's program and is also open to those who wish to spend the summer in review or in further work in chemistry and in teaching problems. It is this program which helps the teacher fulfill the first requirement of the "ideal chemistry teacher."

The Summer program is perhaps the most characteristic aspect of the Institute. Five types of activity are offered: Lecture courses, Seminars in Special Topics of Chemistry, Seminars on the Problems of Teaching Chemistry, Special Lectures, Conferences (workshops).

The lecture courses are mainly of the survey type and consider the fundamental and some of the advanced ideas in the major fields of chemistry.

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High School Laboratory Procedures in Genetics

• By Raymond Heckerman, M.S., *(University of Pittsburgh)*
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The high school teacher of biology who desires to demonstrate to his students the basic laws of heredity will find much practical help in this article.

The use of living plants and animals, as well as preserved specimens, is considered. Materials and procedures are discussed and their merits evaluated. Student projects are suggested as well as demonstrations to be done by the teacher.

Two general procedures are open to the instructor of biology who desires to demonstrate the basic laws of Genetics to his students. They are: (1) demonstration preparations purchased by the school or prepared by the student; and (2) living demonstrations of plants and animals. This paper briefly discusses the methods, materials, and merits of these procedures.

Demonstration preparations of Mendel's principles of heredity purchased from the biological houses are an excellent means of introducing these principles to the high school student. Such preparations are usually constructed within a heavy, rectangular, laminated paper box that can withstand relatively rough usage. Furthermore, a glass or heavy cellophane pane built into the lid enables observance of the contents at all times.

The materials used are in most cases authentic, preserved specimens. Where true specimens are not practical, casts of the organism or structure carrying the trait are substituted. Whether authentic or not, the specimens are mounted in the usual way; that is, to show the parental cross and successive filial generations.

Micro Slides

In most high schools the carrying of live cultures is impossible or impractical. Since this is the case, it might be well to have the student see demonstration crosses of authentic Drosophila. Insects showing easily observed traits have been mounted on micro slides by one of the supply houses. The flies are arranged according to parental and filial generations, and where practical, they are arranged to show segregation ratios.

Waxy and Non-Waxy Maize

An excellent method for demonstrating basic Genetics in high school is afforded in specially prepared pollen and kernels of Maize. A well-known biological supply house has introduced the method using Gram's iodine. It stains the starch particles of the pollen and kernels of the wild strain, but does not stain the kernels and pollen of a mutant variety called waxy.

Preserved tassels of a heterozygous plant can be used by the student to demonstrate the 1:1 ratio of the pollen (waxy:non-waxy). With these tassels the student prepares slides of pollen stained with Gram's iodine and calculates the proportion of light-staining ones to dark-staining ones. The observed ratio in this case is also the genotypic ratio.

The maize kernels mentioned above are the progeny of the waxy:non-waxy pollen and of consequence make up the second filial generation. To analyze, the student must remove the top of each grain and expose the endosperm. Gram's stain is then applied. The waxy and non-waxy kernels are counted and the proper ratio determined. In this case the ratio is a typical F_2 segregation of a monohybrid cross or 3 non-waxy: 1 waxy.

By means of such a laboratory exercise, even though no living material is used, the student will better understand and appreciate Mendel's first law, and the difference between dominance and recessiveness.

Student Preparations

The use of alphabetic symbols to represent genotypes is too complex for the student of high school age; since it is advisable to have the student solve some of the problems on his own, the use of the practice problem has been highly recommended. This is a project assigned by the instructor. The student is required to make a chart of the typical crosses utilizing a specific character. This chart is much like the demonstration preparations previously discussed.

An excellent example is found in the seed of the garden pea. In a given quantity of these seeds some will be smooth, others wrinkled, some yellow and others green. Each set of these contrasting characters segregates into a 3:1 ratio in the F_2 generation. The student selects the appropriate seeds and fastens them to a card in the form of a diagram which is designed to show the types of offspring from the crosses assigned by the instructor.

Many other projects of this sort can be developed by the instructor merely by following examples given in any good textbook on Genetics.

Animal crosses may also be represented in this manner. Miniature casts and toy or cardboard models may be substituted in these diagrams. The choice of the model is left to the ingenuity of the student.

Still other projects of this sort may be taken from problems in human inheritance. The more common ones such as eye color, color blindness, and baldness can easily be illustrated by diagrams. Other problems may even be taken from the student's own family. Thus he can report on an actual case which is very real to him. This should give him a realization of the significance of Genetics in his life and the life of others.

Demonstrations of Living Crosses

Since plants can be handled with relative ease in the classroom, their use in demonstrating the basic laws of inheritance is highly recommended. Excellent results may be obtained with Maize and Jimson Weed (Datura). In either case the seeds are planted in soil-filled wooden boxes of the type used by florists and cared for thereafter in the usual manner.

Strains of Maize containing the factor for albinism can be used as a class project. Heterozygous grains may be planted in the boxes mentioned above; after a period of 8-12 days seedlings will develop sufficiently to show green and albino characters. The students should then count the two types of seedlings and develop the ratio. Since the progeny represent a typical F_2 generation and the trait is determined by a single allele, the well-known 3:1 ratio will be found.

Further problems can be carried out if the school has access to a plot of land for garden purposes. If the heterozygous seeds are used, the albino plants will be found to die within 2-3 weeks. However, the green ones can be raised to maturity and self-pollinated. The resulting embryos may then be planted in the classroom boxes, and counts can be made of the seedlings.

Green and purple hypocotyls in the Jimson Weed are also inherited through a single pair of factors. The methods of cultivation as used for Maize can also be applied here. Counting can begin within 8-12 days. The seedlings will segregate into a 3:1 ratio (75% purple and 25% green).

Pure strains of black and albino mice provide material for still another simple cross. These animals are excellent for use in secondary schools, for they can be handled without too much work and will not involve too long a period of preparation.

The mating between a pure black and pure white will constitute the P_1 generation. As predicted, the F_1 generation of mice will be black but not pure. By inbreeding the F_1 progeny the F_2 generation will be produced and will be found to segregate into a ratio of 3 black: 1 white (albino).

Selection of homozygous black mice using the backcross method may also be attempted. Since this experiment will take longer, it is advisable to divide the work among some of the students. The backcross utilizes the homozygous recessive animals or albinos in all subsequent crosses. Therefore to test a black individual it must be mated with an albino. If all the progeny are black it is reasonable to assume homozygosity in the black parent.

Drosophila Cultures

Drosophila melanogaster is probably the most commonly used animal in the study of inheritance. This insect has a life cycle of 10 days, which is a helpful factor when the observation period of generations is limited by the short months of the school term.

The simplest method for culturing Drosophila is the use of ripe bananas. Merely by allowing ripe bananas to stand open one may obtain the larvae of wild strains. These larvae and subsequent pupae may be continued by transference to other banana cultures. The use of this medium dates back to the beginning of the study of Drosophila; however, superior methods have replaced it.

Commonly used media are agar-cornmeal, tomato paste, and oatmeal. The former contains in every 2 liters of water, 40 gm. of agar, 200 gm. of cornmeal, 140 cc. of corn syrup, 140 cc. of molasses. The agar is added to the water and heated to boiling. Then the cornmeal is added while stirring continuously. After adding the corn syrup and molasses the whole mixture is allowed to boil slowly for about 10 minutes. The cooked medium is then removed and immediately poured into sterilized containers. The amount of medium put into each container is determined by its size; one-half inch for a two ounce bottle to two inches for a quart bottle.

Before the medium has had a chance to harden doubled strips of paper should be inserted. This will provide a place upon which the larvae may pupate. Before adding the insect, place a drop of yeast solution into each bottle.

Superior results have been claimed using the tomato paste medium. To prepare this medium 100 gm. of tomato paste, 100 gm. of white corn syrup, 20 gm. of agar and 1 gm. of Moldex are added to a liter of water. The ingredients are mixed in much the same manner as above. When the insects are introduced the customary drop of yeast suspension is added.

A satisfactory medium which substitutes oatmeal for agar is prepared in the following manner. To a mixture of 45 gm. of cornmeal, 45 gm. of oatmeal, 4 gm. of brewer's yeast and 1 gm. of Moldex is added 25 cc. of molasses and 600 cc. of water. The latter materials are added with constant stirring while the whole mixture is heated over a low flame.

It must be realized, however, that all materials that come in contact with the medium and the flies should be sterilized in order to insure viable cultures. Care must then be taken while transferring flies into other containers. This must be done as quickly as possible so that contamination by airborne spores is at a minimum. If contamination has occurred, the flies should be removed while in the pupal stage and washed in a weak (wine colored) solution of $KMnO_4$. Subcultures should be treated in this manner until the contaminants have disappeared. The possibility of contamination increases with the age of the culture. Therefore, it is advisable to transfer the various strains into fresh cultures every week or so. Mold formation may be deterred considerably if Moldex is employed in the culture medium. This is dissolved in 95% ethyl alcohol then added to the medium (1.5 gm. of Moldex to 5 cc. of water).

Subsequent handling of the flies involves techniques necessary for a proper analysis of the trait or traits in question. The techniques include: (1) isolation of all

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Go Underground!

• By **William R. Halliday, M.D.,** *(George Washington University)*
NATIONAL SPELEOLOGICAL SOCIETY, DENVER, COLORADO

Be a spelunker!

This enthusiastic story of the delights experienced by speleologists should encourage more of our readers to visit the caves to which they have access to study their geological formation and to enjoy their beauty.

Spelunking need not be difficult nor hazardous. The National Park Service, which assumed charge of a number of caves in order to prevent vandalization, has subsequently developed them for the benefit of the public. There are some 125 commercially operated caves scattered over 35 States. Examine the list mentioned in this article to learn if there may be one in your neighborhood.

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Go underground? To the majority of the world's inhabitants the idea is terrifying, sinister, or a last resort against tyranny. To increasing millions of American tourists, however, it recalls scenes of splendor, objects of curiosity or wonder, and very often a sense of nearness with our own glorious history. These are the fortunate ones who have discovered the great wonderland of caves.

At some time in his life nearly everyone has felt the call of our long-gone cave-dwelling ancestors. Most boys have dreamed of pirate caves, or re-lived Tom Sawyer's experiences in a pile of boulders or a shaky tunnel in sand. Many have explored a real cave or two, at least as far as a flashlight and ball of string would take them in relative comfort. Most, however, have turned back when the mud, or water or the realization of that "long way from daylight" became discouraging. A very few find these hazards a challenge and become real spelunkers or speleologists, but the rugged thrills of cave exploration in the rough are not for most of us.

Still, man's curiosity, whetted by the incredible tales of his wider-travelled neighbor, leads him underground. So that he may see and comprehend the wonders of the netherworld, a multi-million dollar industry has sprung up, devoted to the safe and comfortable display of the nation's most beautiful and interesting caves. There are now over 125 commercially operated and developed caverns scattered throughout some 35 states all over America; for the most part magnificently lighted to reveal all the glory of the great rooms and tiny grottoes, mighty columns and dainty crystals. Wide paths have filled rocky stream beds; stairways and bridges carry hundreds a day where explorers not so long ago risked their lives over deep chasms. Loose rocks have been blasted down, and many a "fat man's misery" widened just barely enough.

And is it worth it? Well, to many, the Grand Canyon is just a hole, and a cave is even more so. But to those who have experienced the great black tornado of ten million bats in their evening flight from their private passage at Carlsbad, or who have floated down a weird underground river for what seemed mile after mile, or found ice in midsummer in Idaho with the thermometer at 110 degrees outside, or seen snail-pitted rocks buried amid great breakers inside cliffs along the California coast, or explored lava tubes a mile long, or heard the roar of sea lions or tremendous waterfalls far below the surface, or thrilled at great draperies cascading down the wall of some huge room into crystal pools, nothing *on* the earth is comparable.

TYPICAL STALACTITES and stalagmites. Patton Cave. Earl Walter, photographer.

But why so many? The 25-cent list of commercial caves, made available by the National Speleological Society as a public service*, shows Pennsylvania with 11, Virginia 10, and 7 or more in California, Kentucky, Ohio, South Dakota and Tennessee. Even more remarkable, Missouri had 17 at last count, but in this state commercial caves open and close so often that any count might be wrong next week. And even this number is increasing so rapidly that the Society is issuing a supplement to this 20-page list of caves and their facili-

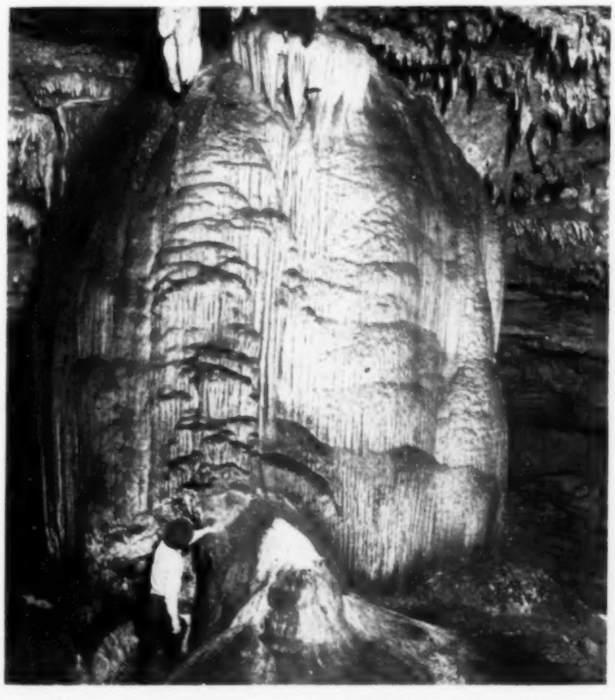
* Available from the Society at 1770 Columbia Rd. NW, Washington, D. C.

ties eight months after the first printing, just to keep up with the new ones.

There may be many caves in this list, it is true, but as so many have discovered, no two caves are alike. Each possesses its own haunting beauty. The variety of formations alone is endless. Each has its own legends and history, intertwined with that of the region or the nation. Local geography determines what kind of strange animals are to be seen, or whether a stream, perhaps with a great waterfall, is to be found tucked away in a niche or occupying most of the entire cave.

In Mark Twain's Cave, on the Mississippi in Missouri, you can truly re-live the story of Tom Sawyer, lost in its remarkable maze. If you are of a different nature, you may instead choose to order a meal in high vaulted chambers in Carlsbad Caverns, in New Mexico, or in Truitt's Cave, in Missouri. The "Ballroom" will be pointed out in nearly every cave, but in Wonderland Caverns in Arkansas, is the world's strangest nightclub-underground. Pennsylvania's Lost River Cave and Onondaga cave in Missouri present brilliant fluorescent displays as part of their underground exhibits. Somewhat different is Penn's Cave, Pennsylvania, where the entire trip is made by boat, as is the famous Echo River portion of the Mammoth Cave, Kentucky, trip, as well as portions of many others. Even if you lack historical bent, the relics and signatures of the Civil War at Melrose Caverns in the Shenandoah Valley of Virginia will impress you. Andrew Jackson's signature dated 1833 in Lookout Mountain Cave, Tenn., will thrill you. The story of the mail bandits who escaped a posse through a secret entrance at Colossal Cave, near Tucson, Arizona, is the answer to the dream of every boy, young or old.

"PANCAKES" forming in a saturated pool. Old Poor Farm Cave. Earl Walter, photographer.



VAST COLUMN FORMATION. George F. Jackson, photographer.

Many caves, by their very nature, contain streams. In some, remarkable waterfalls are to be found, far below the surface. The 145-foot fall in Lookout Mountain Cave would be considered magnificent even in the light of day. Here, with its great roar penetrating the awesome silence of the dark, it is breath-taking. Little less majestic is the great waterfall which is the major attraction of Niagara Cave, Minnesota. Many of the other streams disappear eerily, notably at Mystery Cave, Minnesota, and Cave-without-a-name, the most beautiful cave in Texas. A little different are some of the caves at New York's Natural Stone Bridge, where the thrill-seeker can easily swim from one entrance to another in almost total darkness, a surpassingly weird experience.

As might be expected, the National Park Service has assumed control over many caves to prevent their vandalization, and has subsequently developed them for the benefit of the public. In general, the caves under their management are a little more as nature left them, a little less garishly lit, and a little more accurately explained by the guides, though the outstanding private caverns, such as Luray and Grand Cavern, must be considered at least their equal in such matters of taste. Theirs to display are the tremendous extent, blind animals, and historical interest of Mammoth Cave, and the incredibly decorated and inconceivably huge Carlsbad Caverns, where one room is three-quarters of a mile long. Thus the greatest of our caves are those of the Park System, as well as such lesser gems as Crystal Cave in Sequoia National Park, California, Lehman Caves, a National Monument in Nevada, Oregon Caves, Wind and Jewel Caves in South Dakota, and Timpanogos Cave, Utah. Besides these,

the Park Service has built staircases to the nethermost parts of caves in Lava Beds, California, and Craters of the Moon in Idaho, so that you may explore mile-long, ice-containing tunnels, and in the remarkable boulder caves at Pinnacles National Monument, California, and Anemone Cave, Maine, the only accessible sea cave on the east coast.

State Park systems also offer many magnificent show caves. Florida Caverns in Florida; Lewis and Clark Cavern, Montana, with its narrow gauge railway and inclined cog lift to the entrance; Carter Caves State Park, Kentucky, which includes Cascade Caverns; Longhorn Caverns, Texas, the hideout of Sam Bass in outlaw days; and Lava River Cave, Oregon's finest lava tube, are thus open to the public.

FLOWSTONE "curtains" and Rimstone pools. Charles E. Mohr, photographer.

Even the very rock of some of the caves is different. To those overwhelmed by the thought of the 60 million years that went into the making of Carlsbad, the knowledge that Bear Cave, Michigan, was formed in what geologists call *marl*, less than 25,000 years ago, may seem more comprehensible. La Jolla Caves, Caverns of Mystery and Sea Lion Cave, the sea caves of the Pacific coast with their strange marine population and plants and pitted, banded walls, are not in limestone at all, but show agate, jasper and other mineral veins in their varied chambers.

Caves, then, of every description, prepared and awaiting your visit, are wherever you go, from Lost River Caverns in the mountains of New Hampshire to Mitchell's Cavern in the Mojave Desert of California. All are accessible by highway, and many have bus service practically to the door. Others, like Luray Caverns in Virginia or Pennsylvania's Crystal Cave, arrange special excursions practically from your doorstep all through the year. For your benefit, everything has been made as comfortable and easy as possible. Like Carlsbad, or Shenandoah Caverns, Virginia, many provide elevator service, and some even supply private wheelchairs.

We have left still unanswered the biggest question about these caves. The average person visits them because of the exquisite magnificence of their age-old decoration. Which, then, is the most beautiful, *the one* to visit?

There is little doubt that Carlsbad is the most tremendous and that its massed formations are perhaps unequalled in quantity. Yet Luray and many another cave is more spectacularly draped and splashed with color. The "Angel's Wing" in the Grand Caverns of Virginia, our oldest commercial cave, is widely felt to be the world's most beautiful single formation. But we could go on and on, for each has its own inimitable beauty. You will not be satisfied to see only one. Judge them yourself, and perhaps you will find the answer. ●

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"A good professor is not satisfied merely to induce a student to think; he will also be concerned with the problem of motivating him to act on what he knows. The notion that reasoning by an open, inquiring mind is not in itself the ultimate end of education but that the school must also be concerned with motivating the individual in his action is, I know, strongly disputed by some. Yet, education must concern itself with what a man does as well as with what he studies."

—THOMAS C. DONNELLY
University of New Mexico

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"I do not contemplate the production of educated men and women at the age of sixteen. I recommend only these two things: First, our children should be disciplined in the liberal arts, which means the ability to read and write and speak and think as well as they can. Second, our children should experience some intellectual stimulation and be enticed by learning itself. I would hope that somehow the feast of knowledge and the excitement of ideas would be made attractive to them, so that when they left school, they would want to go on learning. In school they must be given, not learning, for that cannot be done, but the skills of learning and the wish to learn, so that in adult life they will want to go on learning and will have the skills to use in the process."

—MORTIMER J. ADLER

Some Old Chinese Chemical Industries

• **By Henry S. Frank, Ph.D.,** *(University of California)*
HEAD, DEPARTMENT OF CHEMISTRY, UNIVERSITY OF PITTSBURGH, PITTSBURGH, PENNSYLVANIA

Don't miss this out-of-the-ordinary article!

It is an absorbing account of certain Chinese chemical industries of great age that are carried on today much as they were hundreds of years ago. The writer has first-hand knowledge of a number of such processes, gained during his very considerable experience as an educator in China.

Useful products can sometimes still be made profitably by simple empirical methods devised by primitive workers who were, of course, ignorant of scientific principles. Usually, the judgment of the operator controls the process, a procedure not unknown to modern chemical industry.

Introduction

Modern chemical industry as we know it in this country has never existed in China, and attempts to create it have never gotten beyond the initial stage of attempting to "start the ball rolling" by building a modern factory here or there to produce sulfuric acid, caustic soda, ammonia, or some other basic chemical. Factories for all of these were set up in the middle 1930's in a special "Industrial District" which was created by the Kwangtung Provincial Government, in the suburbs of Canton, and there were for a time hopeful signs that the existence of the products they were starting to put out would lead to the growth of industries based on them. The intention was that this should start the circular process by which supply and demand would grow together, other materials be drawn into the picture, and eventually an important step be taken toward the industrialization and modernization of the country.

This experiment, of course, along with others like it in other parts of China, was terminated by World War II, which started in China in 1937. Since that time South China has had very few modern chemical factories, though a medium-sized cement factory, and one or two modern sugar mills were restored after 1946, and dyeing, soap-making, and the manufacture of dry cells for flash lights were carried on in some volume and by more or less modern methods.

Countless old processes have continued to be carried out, however, which illustrate the timelessness of scientific principles. Many of them also illustrate the fact that complicated machinery is not needed for useful practical results. In addition, some of them furnish examples of empirical practices from which useful new scientific results will quite possibly be attainable when more research has been done on them. We shall take as examples (a) the pottery industry in the town of Shek Waan, (b) the making of charcoal in hand-dug clay pits, and (c) the manufacture of the specially sized silk cloth which the Cantonese like so well in warm weather, which they call "Shu Leung" cloth or "Haak Kau Chau."

Special Fuels

Before taking these up, we may pause to note that the use of special materials for special purposes is not confined to what we call modern practice. In Canton there are sold three grades of quicklime, obtained from three different sources—the burning of limestone, of oyster shells, and of clam shells. The oyster and clam limes are generally purer than the stone lime. The clams are a small fresh-water variety, dredged from the bed of the Pearl River, and in cooking them (early in the morning, along the waterfront, for the carriers and longshoremen) a special fuel is used —the shells of olive-seeds. The pits of the olive seeds are used in some quantity as a delicacy in the Cantonese restaurants, which are themselves rather big business for China, and the tie-in between the olive-pits for the epicure, the clam meat for the carrier and longshoreman, the olive seed shells to cook the clams and the clam

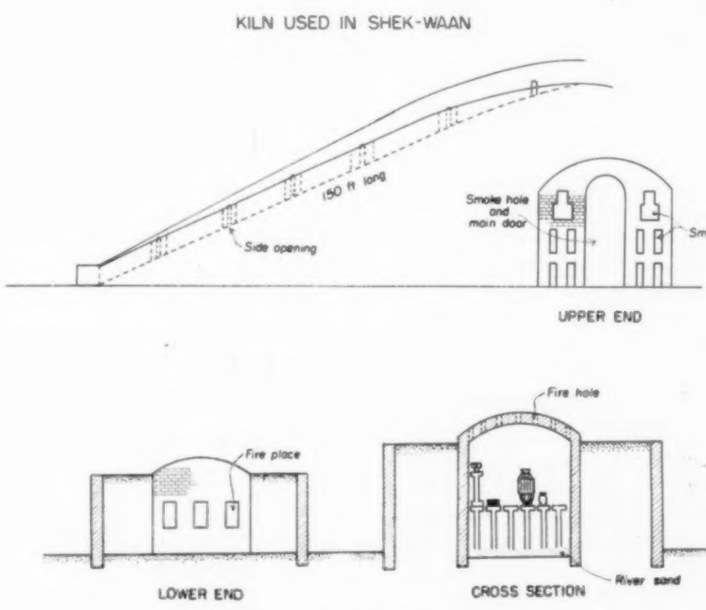

FIG. 1. Diagram of pottery kiln.

shells for lime for plaster, may make up in social and ecological interest what it lacks in industrial and economic magnitude.

Another "special fuel" for a special use is the coarse outer rice husk, which is the only fuel used for the frying to which peanut meal is subjected between first and second pressings for peanut oil. This frying is carried out in thin bowl-like pans of perhaps $\frac{3}{32}$" steel, set in brick fireplaces, and the hot sudden flame and quickness of burning out of the rice husks give a heat that is flexible and easily controlled both as to temperature and duration. This is not in the same class, of course, with the special fuels for special purposes—aviation gasoline, rocket fuels, etc.—which have been developed here, but has in common with them the same germinal idea.

Shek Waan Potteries [1]

The village of Shek Waan is about fifteen miles south and west of Canton, and is almost exclusively devoted to a pottery industry which is a number of hundreds of years old. Originally, apparently, all of the necessary materials—clay, sand, and fuel, were available on the spot, but the pine wood used for fuel was exhausted long ago, and the last of the local clay about eighty years ago, so that only the sand is now to be had in the immediate neighborhood. Clay comes from two localities respectively about 40 and 60 miles away, and is transported by boat, all of the places concerned being on waterways of the Canton delta. The wood for fuel comes down the West River from Kwangsi, travelling upwards of 100 miles.

Clay is blended and mixed with sand by "blunging" in unlined pits, the mixing being produced by treading and trampling, a single workman working a batch with his bare feet. It is then aged by being stuck against a wall, in lumps, and left for a week or more. It is formed by being pressed into molds or by throwing on a wheel, the latter being set just above ground level and spun by friction from the foot of a potter's helper who stands there swinging his leg. The objects made by molding are tile pipe, roofing tiles, and some decorative pieces for building use. Those thrown and turned will be Chinese cooking utensils and water jars and urns. Figurines, etc. are made by hand. All the ware is relatively coarse, and low-burned. All, however, is given some glaze. The basic glaze is dark brown and consists of a slurry of canal mud which is used as it comes. After being painted on the green ware, it fuses even at the low temperature at which the cheapest ware is fired. Roofing tile and some other objects are glazed in green, yellow, and blue. The base glaze for this is canal mud as before, to which lime and powdered bottle glass have been added. Green is produced by adding copper turnings; yellow with roasted lead, and blue with cobalt oxide, which must be imported.

The kilns are very characteristic—long tunnels on the hillside, like slanting chimneys lying on the ground. They may be as long as 150 to 200 feet, and the cross section is an inverted U increasing in size from 3 ft. wide by 3 ft. high at the lower end to 5 ft. wide by 7 ft. high at the top. The slope of the hillside on which a kiln is built will be from 15 to 20 degrees, and will be steeper at the bottom. There were about 30 of these kilns in the town about 20 years ago.

The kiln is protected from sun and weather by a low roof, built in a series of steps, supported on pillars, and without walls. The walls of the kiln itself are about eight inches thick, made of vitrified brick locally burned for the purpose. Access to the kiln is secured through openings in the sides, about two feet wide and three feet high at the lower end, gradually increasing in height to five feet at the upper end. These openings are bricked up while the kiln is being fired.

At intervals of about 30 inches along the top of the kiln are transverse rows of fuel holes, each not over two inches in diameter, through the top wall, into the kiln. There are three holes in each row near the bottom and five near the top. These holes, when not in use, are closed with sandy clay. Figure 1 is a diagram of one of these kilns. All kilns are repaired once a year, and rebuilt every three years.

For firing, the fuel used is pine wood, as mentioned above. This is cut into pieces about 15 inches long and one inch square in cross section. A fire is built at the lower end of the kiln, and the smoke goes up through it, warming the articles therein. When the fire is hot enough, and sufficient draft has been created, no more fuel is added to the fire at the bottom, but the burners take their places at the transverse holes and feed the fire by dropping wood through the first row of fuel holes. When the master burner judges (by looking through the holes) that the fire is hot enough, the burners move up to the next row and add more fuel there. The fire is then fed successively through each row of holes all the way up to the top. It takes about 35 pounds of wood to fire 100 pounds of ware. As the fire at the bottom gets hot soon and goes out before long, the thinner articles such as cooking-ware are loaded near the bottom. The heavy articles are generally loaded in the upper end. Figure 2 gives a heating curve near the upper end of the kiln.

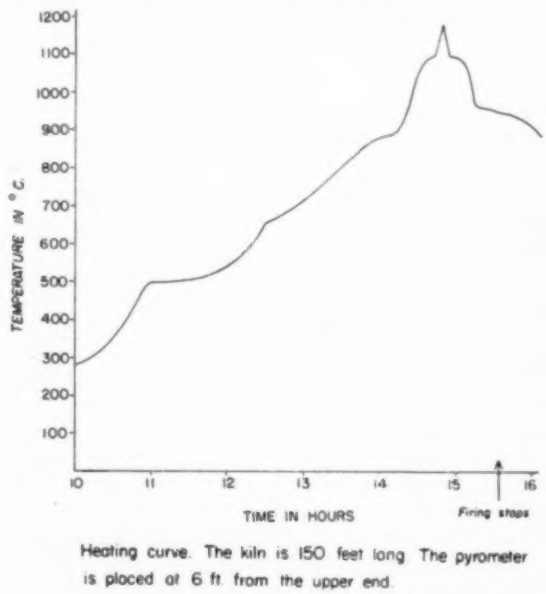

FIG. 2. Heating curve near upper end of pottery kiln.

Following the firing, the burners change function and glaze another set of articles for the next run, putting them on top of the kiln and beside it, to be dried by the heat which is otherwise wasted. A kiln is allowed to cool for about 14 hours after firing, and unpacking it is a hot job, being done while the temperature of the articles and the walls is about 150°C. This is to prevent cracking (of the kiln), and to save fuel for the following run. Before the Japanese war (when these data were collected) about one-third of the product of this industry was used by the people of Kwangtung and one-third in Hong Kong, the rest being exported for use by Chinese living in Southeast Asia and Indonesia.

Charcoal Burning

A more primitive industry is found in the manufacture of charcoal as practiced in the mountain regions of Kwangtung province. The antiquity of this is unknown, but must run to many centuries. Here, the exercise of ingenuity has made it possible to dispense with all but the simplest materials and implements. The "furnace" is a hole in a clay bank, and is illustrated in Figure 3. A more or less step-like conformation of

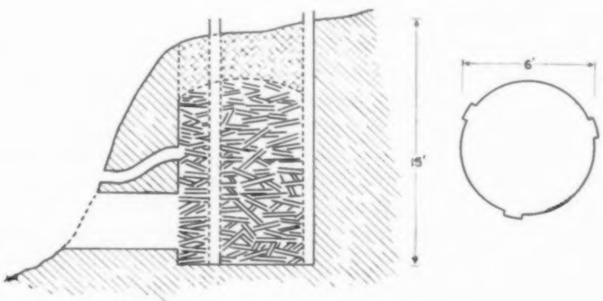

FIG. 3. A charcoal burning "furnace."

reasonably clayey earth is selected, and a circular hole, about 6 feet in diameter is dug to a depth of perhaps 15 feet. At three equidistant points around the circumference rectangular recesses about a foot in width increase the diameter by about 6 inches. The front face of each of these is closed with brick or coarse tile, leaving an opening of six inches or so at the bottom, making three flues, to carry gases from the bottom of the furnace to the outside air.

Two tunnels are dug, as shown, from the "well" to the face of the bank. The first is about 30 inches high by perhaps 18 inches wide, and is designed to permit access to a boy or small man (by crawling) for loading and unloading the furnace. The other is circular, about 10 inches in diameter, and is curved in three dimensions, starting low (often beside the loading tunnel) and entering the furnace at a higher level.

After the well is first dug it is charged with the branches to be converted to charcoal, usually small or irregular ones unsuitable for lumber or the straight sticks of cooking-firewood (similar to what the ceramic kiln is fired with). This is built up to a height of six feet or more, and then covered with sticks and straw to support a clay roof which is tamped in on top of it in an arched formation. Short lengths of tile pipe are placed as outlets for the flues previously described.

A fire is built in the charging tunnel, and after this has caught in the mass of the furnace charge, the tunnel is bricked up and luted with sandy clay. The fire continues to burn using air which enters through the curved inlet, until the smoke from the flues has an appearance and odor which suits the master burner, after which the inlet is also sealed, and the exothermic pyrolysis of the charge continues in absence of air. When the flue gases again suit the master burner in volume, appearance, and odor (after about 24 hours) the tunnels are opened and the charge removed. This leaves the curved clay roof of the furnace intact, and it remains a permanent part of the "installation."

The furnace is now re-used in routine operation, which follows the same cycle. The quality of the charcoal is usually excellent. The wood commonly used is pine, but when other woods are available they can also serve.

This is another example of the successful control of a technical process by a foreman who uses his experience and his "eye" to judge when a given process has reached completion. It is instructive to compare this with the similar judgment employed for so long in the steel industry in this country where, for example, "reading carbon" from the fractured surface of a test piece has been used to control open-hearth operations. There are better ways of running a big industry, but no one who likes home cooking will doubt that the method of judging by experience can be effective when practiced by a competent "expert."

An interesting exercise in a primitive sort of chemical engineering and in economics is presented by the question whether passing the flue gases from these charcoal furnaces over a trickle of lime water (lime is burned in the country also) would absorb enough acetic acid to give a calcium acetate solution which could be evaporated using the heat of the furnace-top, so that solid $CaAc_2$ could be carried to the city for distillation to acetone, all at a profit. This would seem to be one way by which this process might be adapted to production of by-products.

"Sized" Cloth[2]

The Cantonese weave a fine silk cloth, strong but thin, transparent, often having a pattern woven into it. To make it suitable for hot-weather clothing they give it a black sizing-like coating, which is based on a vegetable gum dye which they call "shu leung." This comes from a tuber of the genus *dioscorea*. The tuber is grated and steeped in water, and the juice used to soak the cloth, which, for this purpose, is woven in pieces two feet or so wide, and perhaps 60 feet long. After one soaking the cloth is stretched out on a flat grass lawn and dried in the sun. Then it is soaked again and dried again, this process being repeated sometimes up to 30 times. At the end of this sequence, the cloth is rather stiff (as from a light starching) and an orange-

(Continued on Page 111)

Folic Acid and the Control of Anemia

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Folic acid is a water-soluble vitamin of the B complex found in green leaves, liver and yeast. In composition and physiological effect it is quite different from vitamin B_{12}, the anti-pernicious-anemia substance found in concentrated liver extract.

Folic acid has been synthesized (1945), and many clinical applications have been found for it, especially in the prevention and treatment of certain anemias associated with nutritional deficiencies.

New facts concerning the chemical changes that take place in living tissues are being discovered through the experimental use of this valuable agent.

●

Folic acid is a water-soluble vitamin which belongs to the B complex. It is present in many foods, especially green leaves, liver and yeast, and it exists in natural sources in several chemical forms.

In the pure state, folic acid is a yellow crystalline substance which has the formula $C_{19}H_{19}N_6O_6$. Its chemical name is pteroylglutamic acid, and its molecule contains pyrimidine and pyrazine rings which are joined together to form a "pteridine" grouping. This is linked by a methylene bridge to para-aminobenzoic acid which is joined by its carboxyl group to the amino group of L-glutamic acid.

The term "folic acid activity" is used in reference to a group of substances which are biologically active in producing growth of the microorganism *Streptococcus faecalis* under conditions in which a response is obtained with pteroylglutamic acid. This group includes certain chemical relatives of pteroylglutamic acid, including "citrovorum factor" (folinic acid, leucovorin), "rhizopterin" and pteroic acid. Pteroic acid is identical with pteroylglutamic acid *minus* the glutamic acid radical, and "rhizopterin" is pteroic acid with a —CHO group attached to the *p*-aminobenzoic-acid-nitrogen atom. The glutamic-acid radical of folic acid in natural materials may be conjugated through peptide linkage of the gamma-carboxyl group to one or more additional glutamic acid groupings. These linkages are broken by enzymes, the folic acid "conjugases," which are present in kidney, liver, pancreas and other tissues.

Many years elapsed between the first observations of folic-acid deficiency and the isolation of this vitamin in the pure state. A disease due to a lack of folic acid was described in 1931 by Wills, whose clinical studies in Bombay, India, first differentiated folic acid from the anti-pernicious-anemia substance of concentrated liver extracts which is now known as "vitamin B_{12}." Wills found that pregnancy in nutritionally-deficient Indian women led to the development of "tropical macrocytic anemia." This disease was alleviated by crude fractions of liver and yeast but it did not respond to the administration of anti-pernicious-anemia liver extract. In the years which followed, analogous deficiencies of folic acid were produced experimentally in many species including monkeys, chickens, rats, protozoa and bacteria. The unknown vitamin received various names including "vitamin M," "factor U," "yeast norite eluate factor," "folic acid" and "vitamin B_c". Finally in 1943 the isolation of the substance from liver and yeast was reported and in 1945 and 1946 its synthesis and chemistry were described. These developments have been reviewed at length[1].

Folic acid found many clinical applications in the years following 1945, and it is now established as a therapeutic agent in the management of the megaloblastic anemias which are associated with nutritional deficiencies. The relationships of folic acid with the anti-pernicious-anemia factor of concentrated liver extracts (vitamin B_{12}) are of special interest. It was demonstrated first by Wills that the anti-pernicious-anemia factor would not alleviate folic acid deficiency in human patients and in monkeys. Experiments by O'Dell and Hogan, and in our laboratory, showed that concentrated liver extract was almost devoid of folic acid activity when tested with chicks and with lactic acid bacteria. Consequently, the findings by Spies and by Moore that folic acid would produce hemopoietic remissions in pernicious anemia were unexpected. Later studies by Vilter and co-workers and by Hall and Watkins showed that such patients were not protected against neurologic changes and it became evident that the biochemical lesion in pernicious anemia was dual in character.

One defect in this disease is centered in a disturbance in the nutrition of the bone marrow which enters a stage of "megaloblastic arrest," leading to a diminution in the number of the red and white cells in the blood stream. This condition is ameliorated by either folic acid or vitamin B_{12}. The second defect is manifested by progressive and degenerative changes in the central nervous system which are expressed by paresthesia, glossitis, and a loss of proprioception. Vitamin B_{12} is needed for prevention or stopping of these changes. The metabolic defect in pernicious anemia is due to a loss of the function of the gastric mucosa, which no longer secretes a protein-like "intrinsic factor" that is needed for the assimilation of vitamin B_{12} from the gastro-intestinal tract.

Recent interest in folic acid has centered around (1) the "citrovorum factor" and (2) the enzymatic transfer of single-carbon units. The work of Sauberlich showed that an unidentified substance was needed for the growth of the lactic acid organism *Leuconostoc citrovorum*. This substance was shown to be related

chemically to folic acid. Its synthesis and structure were described by Shive and co-workers and by the Lederle and Calco research groups. The synthetic substance is 5-formyl-5, 6, 7, 8-tetrahydro pteroylglutamic acid (Figure 1) and is known by the trivial names of "leucovorin" and "folinic acid S.F." It is more active

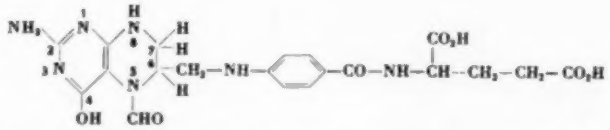

FIG. 1. Leucovorin, 5-formyl-5, 6, 7, 8-tetrahydro pteroylglutamic acid. This is presumed to be a racemic compound due to the formation of a new optically-active center at position 6 during synthesis.

than folic acid in certain biological systems, particularly in reversing the toxic effects of *folic acid antagonists*. Leucovorin is a white crystalline substance, sparingly soluble in water, stable in alkaline solutions but easily destroyed by dilute acid. It produces hemopoietic responses in the megaloblastic anemias in the same manner as folic acid. As little as 75 micrograms injected daily has been reported to lead to a maximal response in two cases of megaloblastic anemia in infancy[2].

The biological activity of both folic acid and leucovorin, and the presence of an additional carbon atom in the latter substance make it tempting to speculate that folic acid by reduction and reversible addition of the formyl group participates in the transfer of the "single-carbon fragment" in living systems. There is some evidence that folic acid is concerned in the following biochemical systems[3, 4].

1. The production of "formate" from glycine and the union of formate with glycine to produce serine.
2. The methylation of aminoethanol to form choline and of homocystine to form methionine.
3. The methylation of the pyrimidine ring to form thymine.
4. Introduction of the 2- and 8-carbon atoms into the purine ring.
5. Possibly in the introduction of the amidine carbon atom in the imidazole ring of histidine.

Much interest has arisen from the numerous clinical observations which have established the fact that folic acid will produce a hemopoietic response in the various megaloblastic anemias. The neurological disturbances in pernicious anemia are relieved by vitamin B_{12} or liver extract containing this substance, but folic acid has been found to bring about a hemopoietic remission while not arresting the progress of the neurological disturbances. Some investigators discussed the possibility that folic acid actually aggravated the neurological symptoms in pernicious anemia[5], but later studies showed[6] that neurological relapse did not progress in pernicious anemia when liver extract or vitamin B_{12} was administered even though folic acid therapy was continued for periods ranging up to 48 months. The incidence of sub-acute degeneration in pernicious anemia varied from five per cent to 97.7 per cent prior to the introduction of therapy, the variation being in part due to the criteria of "neurologic disease" employed by various authorities. Chodos and Ross concluded that because of this variability it was not possible to state definitely that the incidence of sub-acute combined degeneration in folic-acid-treated patients was greater than would have occurred had the patients received no therapy at all[6].

The importance of folic acid in the processes of life is mirrored in the observation that the synthetic "anti-folic-acid" compounds are in many cases strongly poisonous. These compounds, the "folic acid antagonists," may act by displacing folic acid from its place in the living cell. One of the most powerful of these compounds is called "aminopterin" and it is identical with folic acid except that it contains an amino group instead of an hydroxyl group on the pteridine ring of the molecule. One part of aminopterin in one million parts of purified diet has been found to kill white mice within a week. In very small doses, aminopterin is used in the experimental treatment of leukemia in children, so as to attempt to stop temporarily the overproduction of white cells. The toxic effects of aminopterin for animals are preventable by leucovorin, but folic acid has little or no effect in this respect. There is evidence that aminopterin blocks the formation or liberation of a leucovorin-like compound in animal tissues and that this compound is normally formed when folic acid is supplied to such tissues[7].

The use of folic acid in medicine is another step forward in the prevention and treatment of nutritional disease. In certain anemias, especially the megaloblastic anemia of pregnancy, folic acid is a life-saving drug for which no substitute is known. New facts concerning chemical changes which take place in living tissues are coming to light through the experimental use of folic acid. ●

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"A basic principle of our own democracy, the one for which our founders decreed free speech and freedom of assembly, is one with a basic principle of liberal education; the power of self-criticism. Self-criticism does not come from masses of people who are encouraged to conform to a pattern. It comes from a society animated with the vision of our highest aspirations—and that vision will always originate with men and women of philosophic minds and high principles."

—DANIEL Z. GIBSON
President, Washington College

Human Genes

● By Sister Jeanette Obrist, O.S.B., Ph.D., *(The Catholic University of America)*
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The study of biology need never be dull.

Here an alert teacher has interested her class in some simple research problems on heredity that were well within their understanding and ability.

This paper should stimulate other teachers and students to undertake similar problems. In this case the excuse of "expense" is not warranted.

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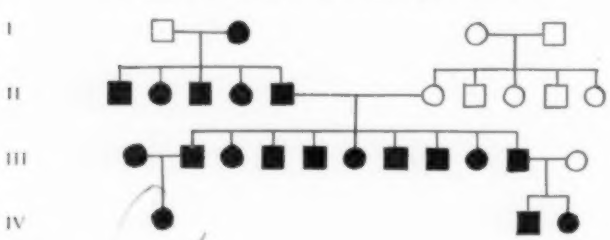
The rediscovery of Mendel's laws of heredity in 1900 opened a fertile field of biological research. Geneticists explain these laws by the gene theory, which says that each chromosome in each nucleus in the germ cells of an organism consists of numerous regions called genes. Each gene has definite capabilities. Some genes are wholly responsible for a characteristic in the offspring. Some control the development of widely different characters. Others again, can produce an effect only if several other genes are present.

This information concerning genes has been obtained by experiments carefully planned and performed with plants and animals. Although individual genes have never been observed any more than single atoms have been seen, much information has been obtained concerning them by indirect methods, both by study of the progeny and by cytological observations. Before any of these valuable experiments could be performed, the experimenter had to be sure to obtain a pure breed. This, in turn, required frequent inbreeding until no variation appeared in the offspring through several generations.

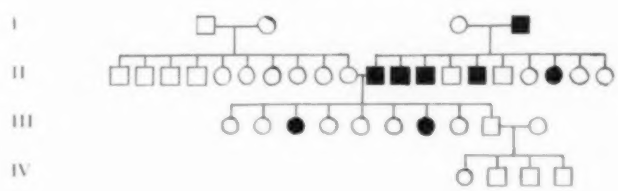
In the case of human heredity no pure breed can be obtained; hence geneticists must rely on pedigrees. Daily more and more pedigrees are being recorded and many yield interesting and even valuable information. Several pedigrees which show the presence or absence of certain physical characters were collected by students in my genetics class this year. They are given below. The following symbols are used in all the charts: a square represents a male, and a circle, a female; the symbols which are solid indicate that the individual has the character in question.

Broad, Dark, Low-arched Eyebrows



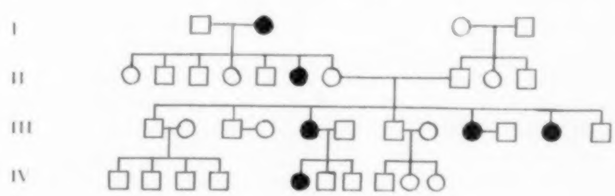
This pedigree traces the presence of broad, dark, low-arched eyebrows. This character is so striking that an individual from a distant city was stopped on the street and inquiry made if he were not a member of a certain relationship. The chart shows twenty-eight individuals belonging to four generations, nineteen of which have the character under discussion. Whenever an individual with the character married a person with the average width or narrow eyebrows, the children all possessed the broad, dark, low-arched eyebrows, thus indicating that this character is dominant to other types. The accompanying photograph shows the eyebrows of a member of the third generation.

Missing Left Incisor



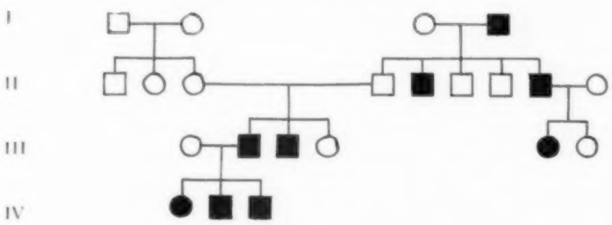
The individuals with a left incisor missing are represented by solid symbols. This character causes a slightly unusual shape of mouth because the first right incisor holds the middle position. There are thirty-eight individuals in this pedigree. This character shows some dominance because it is present fifty per cent of the time in one line of the second generation. The accompanying photograph is that of a member of the third generation.

Hammer-toe



The character of hammer-toe is a minor deformity of the little toe, as shown in the accompanying photograph. This picture was taken of the foot of one of the members of the third generation. Thirty-six individuals of four generations were studied and six had the character. All six were female members of the relationship and hence the gene responsible for it may be located in the x-chromosome.

Widow's Peak



Since this character is not self-explanatory a more detailed discussion is in order. A widow's peak is defined as a point in the hairline on a person's forehead, once believed to be an omen of widowhood. There must have been some famous woman having a peak in the hairline who became a widow, and probably through coincidence, the legend grew that a peak in the hairline indicated early widowhood. Due to this fact. headdresses worn by widows through history had this peak over the forehead. A costume book in 1530 spoke of the "peake of a ladyes mourning head." This feature was also mentioned in the head coverings of 1833 and 1849. In Bray's book *Tamar and Tary* mention was made, "Wishing that she would have . . ., a pair of fine peaks as they were called, one being on either side of the forehead, she caused the hair to be regularly shaved."

A widow's peak was considered a mark of beauty in the 18th century and pulling of hair was practiced by some ladies to achieve the desired effect.

This is a sketch of a widow's bonnet as worn by two queens, Catherine de Medici in 1555, in black with scalloped piece over the forehead, and Marie Stuart in 1560, in white with barbe pearl-edged piece over the forehead.

For this pedigree forty-three persons were examined. Only twenty-two are shown in this chart because the other twenty-one only verified that the female that entered the pedigree in the third generation had no heredity for the widow's peak. Of the twenty-two represented, seven males and two females show this character. The photograph shows the widow's peak of a member of the fourth generation.

This short paper gives only a hint of conclusions that might be drawn if consistent records were kept following these characters through several more generations.

In man, as in plants and animals in general, each character has its own degree of dominance each time it appears in widely separated lines. Hence one must study each mutation to discover whether the usual or unusual, normal or abnormal, healthy or pathogenic gene is dominant. ●

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"We need to go to school, not in order to learn how to earn a living, but in order to learn how to use the life for which we are going to earn a living—to learn how to occupy ourselves humanly, to live our leisure hours well and not play them all away. We need to learn how to do well what we are called upon to do as moral and political agents, and to do well what we must do for the cultivation of our own minds."

—MORTIMER J. ADLER

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"Even the spirit of meditation has been lost from the up-to-date college campus. The grove of Academe has been cut down to make way for a parking lot or a stadium. The calendar is so crowded with extracurricular activities and events that seldom does a student find it possible to yield to the temptation to be alone with his speculations."

—DANIEL Z. GIBSON
President, Washington College

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"Evaluation has no meaning except as it is a process of attempting to determine to what extent a school is realizing the aims and objectives it has set for itself. When the aims and values which govern the operation of the school are clearly defined, teachers and administrators are ready to collect data from all possible sources to appraise their efforts, but, until this clear definition is achieved, evaluation is apt to be only a mechanical and meaningless gathering of unrelated facts."

—G. MAX WINGO
University of Michigan

Coda to Biology

• By Vera Koehring, Ph.D., *(University of Pennsylvania)*
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This thoughtful paper encourages teachers to go beyond the facts and theories of science to develop a fuller appreciation in their students, leading them to understand, to admire, and sometimes to fear.

Dr. Koehring shows objectively how the facts of biology can be presented and interpreted in such a way as to stimulate interest, encourage a desire for more knowledge, and develop an attitude of appreciation.

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The biologist strives to obtain and present his material without formulating any values with regard to it. He has been as objective as his subject matter allows him to be; this, when he is assailed continuously with examples and magnitudes of mystery-marvel creating subjectivity by the force of their impact upon the imagination.

It is essential to establish and arrange facts as facts, and theories as derived from facts, all narrowly considered as objects. But in the last analysis we must evaluate. If we do so with critical discernment the attitude of appreciation is developed. Appreciation may be regarded as a creative level of experience, a synthesis which treats of facts in final analysis.

Surely it may be well these days to try to teach our subject on through to this coda of finality, definitely helping each other to learn to see farther through the facts we have studied,—into evaluation; and to admit that we love life the more by reason of knowing of its structures and processes.

Thus we dare to present our facts in such order as to bring out our admiration for certain conditions, and our fears with respect to others. We are not afraid to fear. Great mistakes have been made in life:—great mammals and great peoples have disappeared from the earth. The mammoths became extinct, Cro-Magnon man and the Sumerians of Mesopotamia disappeared. We may well inquire as to how and why.

Lower animals show that their individuals are little more than highly functional reproductive sacs, ruthlessly sacrificed to their products. When we see a form of life in which the individual, beyond this primal capacity, stands superbly for himself we inquire if we fully appreciate this crowning accomplishment and understand the factors which are involved in such individualization.

That we do not fully comprehend the Person is apparent in that we have not yet learned to treat ourselves universally with the dignity and care that the still-evolving Person demands. During our entire history, as man, we have had to deal with various forms of insidious slaveries, with both benign and malevolent oppressions; and always with inadequacies in our man-made environment. If we wish to foster the independent biological person to full capacity we will need, collectively, to take care of him, as an individual. The vital individual could easily disappear from the earth as such. As in various herds, flocks and swarms of tenacious group strength, the individual could be stampeded in great social forces, and become, individually, lost in subservient roles to super-societies.

Is there any tangible approach to consideration of such subjects? Perhaps; we can begin by using our old well known facts and searching through them for tentative working attitudes.

Now let us say, to give point and suggestion for immediate use of our ideas, that a school is planning an exhibit in which various groups set forth their materials in such manner as to elicit interest, intramurally and in the community, in the aims of each branch of learning. What may the biologists contribute to such an exposition?

The following plan for an exhibit of this nature suggests types of display—each as a problem. There is nothing new in the material. The novelty is that we use it subjectively.

THE BIOLOGIST'S MANIFESTO

An Exposition

From our amoebae and algae to old wise men and old oak trees we study manifestations of life, its adventures, its inventions.

We find universal substances and processes; we see details of the great identities of structure and behavior common to all living.

This factual explicitness builds a knowledge of the ancestry and the generic heritage of men.

We possess the data which reveal the development of our pattern and the repetitive ways of all life, as they are repeated in us.

Some of the inventions we find in vertebrate life and ourselves, and trends we see in evolution thrill us with hope for the continued youth and vigor of the human race.

Sometimes we believe we see danger signals.

(Charts for each item in the exhibit indicate the nature of the materials.)

Life Substance Must Move in Flow and Stiffen in Reverse of Flow

1. See a bowl of gelatin, colorless as is the colorless groundwork of the substance of all life—the protoplasm.

   Stir it and see that it moves, flows, and readily distributes particles held within it.

* Fulbright grantee, 1950-51: United States Educational Foundation in Burma.

We call this flowing state, in protoplasm, a plasmasol; and know that it is a condition necessary in various functionings, including movement within the cell units of life.

2. See a second bowl of gelatin, firm, difficult to stir, and holding particles within it relatively immovable. There is a certain amount of rigidity here. When we see protoplasm rigid we call it plasmagel. We see that the stiffness imparts strength, although diffusion of particles, and even circulation of solutions within it, is slow.

3. Under this magnifying glass we see giant amoebae moving about on the floor of their culture dish. The granules within them show that the protoplasm is constantly changing and reversing from sol to gel states. Life requires both states, alternating.

   In some types of injury to living cells their protoplasm becomes all sol, or very liquid; and movement ceases and the cell may burst. In other types of injury the protoplasm gels and the cell may die small and rigid.

> *The constant sensitiveness and responsiveness characteristic of growing and finely adjusted life we know to be due to this type of change. Life is not static. Life maintains a delicately shifting equilibrium. We meet the external forces of change with internal change. The ability to change is paramount in life. To change, that is—in the right direction for favorable change,—is even a biological responsibility.*

Life as an Individual Unit

1. In this flask there is a sheet of mold which grows without limits, without definite boundaries, as long as the environment, such as this flask, will support it. There are few examples of life occurring thus without form. We scarcely know whether it is primitive or degenerate.

2. In this large dish are a number of minute animals. (Such as snails, tadpoles, guppies, water fleas.) All of these are forms, with precisely delimited structure and regulated growth and size. This type of individual pattern in animal life prevails; there are few colonies of animals bound together in any degree.

   But note that these animals all appear so similar that a single individual cannot be followed for long as it swims about.

3. In this cage a hen appears as quite an individual with considerable "personality." Which uniqueness she displays most markedly, however, as one among others in her flock where she is part of the "peck order." First in order when she left her flock for this occasion—the dowager hen—she may possibly be reduced to the last, lowest order by this, perhaps from a hen's point of view, unfortunate experience. Or, more happily, she may, by some prestige fortuitiously picked up here, be enabled to retain her lead upon her return even more successfully among the unexperienced hens of her flock.

> *In higher life we note variations toward individuation and personality.*
>
> *In human life these variations are so numerous and finely developed that no two persons in the globe's population are precisely alike, save only that they were formed from a single egg cell as identical twins.*
>
> *This wealth of individuality and personality is the wealth of the human race. Individuality in structure is correlated with individuality in behavior. We will NEVER be driven as hordes.*

The Hand with Fingers

1. Here is a living frog and a salamander or newt; and here are frog and newt "hand prints." Here also are models of dinosaur prints. We know that these many fingered hands are basic and primitive in both fossil and living lower vertebrates, the first to live on land. Let us see how the hand has evolved in higher animals.

2. Here are specimens or models of the fore feet of mammals. (Such as rabbit, horse, goat, elephant, bear, seal, dog, etc.) We see that each one is highly changed from the original many fingered form. In some cases remnants of the lost or partially lost fingers remain.

   These examples show how evolution tends toward specialization as each one of these hands becomes highly adapted for primarily one special function. The process of evolution thus reaches an end-point as in the horse's hoof, beyond which it can no longer work if the animal is to survive. The horse is a finished product so far as its feet are concerned.

3. Here are human hand prints, which have five long highly separate fingers. These hands are closer to the primitive condition than is the hand of any other non-primate mammal.

   We have been spared extreme specialization. We have a flexible, primitive hand adaptable to many intricate tasks.

   We believe that there is no end-point here, but rather a vast open field for learning ever more intricate and delicate functioning.

> *We are afraid of extreme specialization. The tendency toward restriction adapted for one or a few specific uses,—undoubtedly a tendency in evolution,—seems unfavorable for flexibility and wide usage.*
>
> *Development in many directions, for many purposes, entailing greater fineness in numerous adaptive situations, is far more favorable and indicative of a future of infinite variation.*
>
> *We hope that the processes of evolution do not bring us to end-points, thus closing for us avenues of wider and greater experiences. An "all-roundness" of life appears very desirable to us.*

Dead Shell Skeleton Versus Living Internal Skeleton

1. Here are corals and oysters and snails and crabs and beetles. Some have lighter and more articulated skeletons than others. But all of these wonderful protective coverings are of non-living materials. Some are so heavy that their owners must give up

locomotion, for the protection of armour. Even the beetle and the snail are encumbered.

2. A skeleton which is both support and armour must be discarded for a new one if growth is to continue. Here are the shed skeletons of crabs, king crabs and cicadas. The formation of new skeletons, the splitting out of old ones, and hardening the new ones, are all long and even dangerous processes during which the animal is relatively helpless and at the mercy of its enemies. In many ways the armour type of skeleton is "expensive" in formation and up-keep.

3. Here are examples of the living type of inner skeletons which we possess:—transparent preparations of chick and mouse skeletons; X-rays of bones, broken and healing themselves; and sawed sections of beef bones to show the relation of living flesh outside the bone and the inside living marrow where the body's blood cells are formed. And the bone cells themselves are living, actively secreting their limey framework, and even giving back to the body this lime in time of starvation. Our skeletons are far more useful than for the one function of support.

We are fortunate in the type of skeleton we possess:—its lightness and strength, its constant growth and response to the body's needs. Gladly we forego an armour to be able to LIVE in our bones, and to be able to take care of our bones, that they are not too soft or too brittle, nor age too rapidly. We carry no dead timber about.

Brain Capacity Rather Than Size of Skull

1. Here you see a series of mammal skulls with a note of the weight of each. Before each is a dish of grain which has been used to fill the brain case and thus measure its capacity for brain tissue. You will see that the weight of the skull and the brain capacity do not correspond. (Our mathematicians have figured ratios.) We see our own thin walled brain case with the greatest capacity.

2. Here, under a magnifying glass, is a section through brain tissue. It is composed of millions of cells. There is evidence that the ordinary human, and perhaps even the greatest of persons, uses but a small number of these millions of cells, which we possess.

How to USE our brain tissues?—the miracle being that we have more than we need at the present level of life. We feel that there are higher levels of life, greater than we can now begin to comprehend. How to reach them?—We have no other answer than—

TO TRY!

The Senses and Their Extension

1. Here you see an angel fish in an aquarium. The fish is so heightened, elongated dorso-ventrally, that balancing becomes a delicate feat. And here is a doll model of a human walking a tight rope. Both require the most sensitive of balancing organs, the universal type of which is shown in this dissection of a dog-fish skull and labels which show the position of the balancing organ.

   This fundamental sense organ, laid down in the skulls of our earliest fishes, evolves scarcely at all in any higher vertebrates. We all have the same equipment in this respect.

2. Here is a bat suspended in a little model of a dark cave. We know that the bat possesses a highly evolved sense that so functions that even in darkness the bat is always oriented in space with regard to boundaries and obstacles. If we possess this same sense it is to such slight degree that it is impracticable in usage.

3. Here is a model of a pigeon and a broadcasting tower. We know by experiments with homing pigeons that these birds are sensitive to broadcasting waves and other waves for which we as humans have no perception.

4. Here is an exhibit of microscopes, telescopes, gyroscopes, electric potentiometer, photoelectric cell, radar unit, Geiger counter, radio, etc. For we as human beings know that we do not see, nor hear, nor smell, nor taste, nor touch with the sensitivities of many other creatures. We have discovered our deficiencies. And we have learned how "to make up for them"—how to extend our senses and discover a greater world than we could have believed existed. We had already done this same type of thing with respect to tools, extending our arms, fingers, legs, voices, even our longing for wings—all over the world.

This tendency to look for our deficiencies and to recognize our frailties is of great value. For so vigorous and ingenious is the human race that we clothe ourselves when we are naked, hear when we are deaf, find out the atom when it is hidden behind the veils of mystery.

And most important:—it is the many senses, the numerous perceptions that we are supplying and developing. Not in one direction alone are we concentrating, but toward the broadening of the complete horizons of life.

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Do we need to go on enumerating exhibits when all biologists will think upon their favorite examples of these appreciations of biological "situations"?

It is time that we take our superb collections of biological data and use them, for our delight and profit. Herein lies stimulus toward more knowledge. But even more important perhaps, herein lies inspiration in the directional use of the knowledge we possess. ●

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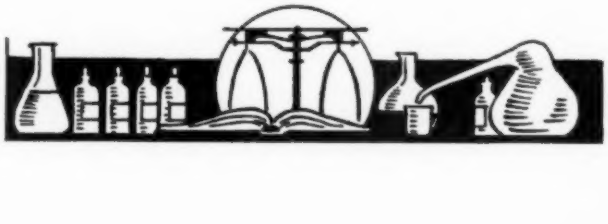

The Use of Fertilizers in the Garden[1]

• By J. B. Edmond, Ph.D., *(University of Maryland)*
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This fact-filled paper gives a wealth of information that will be of service to the horticulturist, the farmer, the botanist, the teacher, and the general reader.

Dr. Edmond discusses the materials used in greater or lesser amounts in modern commercial fertilizer practice. He tells how they are applied, and points out the plant symptoms that indicate deficiencies or excesses. He shows how soil acidity affects the absorption of nutritive materials, and even how soil temperature influences the time of fertilizer application.

The green plant is actually a chemical factory. Certain relatively simple compounds are used, either directly or indirectly, in the formation of relatively complex compounds—the carbohydrates, proteins, fats, and related substances. These simple compounds may be considered raw materials, and the carbohydrates, proteins, fats and related compounds may be considered manufactured products.

In general, the raw materials are divided into two groups: (1) compounds which are not used in commercial fertilizer practice, and (2) compounds which are used in commercial fertilizer practice. Since any one of these materials may limit the rate at which the manufactured products are made, a working knowledge is desirable of the role of each of these compounds and how best they may be supplied.

Raw Materials Not Used in Commercial Fertilizer Practice

The raw materials which are not used in commercial fertilizer practice are carbon dioxide and water. As is well-known among students of plant life, these substances are the raw materials for the fundamental process known as photosynthesis. In general, carbon dioxide and water combine through the agency of chlorophyll and in the presence of light to form certain carbohydrates and related substances. In this way, the energy which comes from the sun is fixed in the green tissues of plants in useable form for all living things. This fundamental process is illustrated as follows:

$$\text{Carbon dioxide} + \text{water} + \text{light} \xrightarrow{\textit{(chlorophyll and enzymes)}} \text{foods} \left\{ \begin{array}{l} \text{carbohydrates,} \\ \text{proteins, fats} \\ \text{and related} \\ \text{substances} \end{array} \right.$$

Carbon dioxide supplies the carbon in the formation of all the many products made by green plants, the numerous forms and varieties of carbohydrates, proteins, and fats. The source of carbon dioxide is the atmosphere. As long as photosynthesis is taking place, the gas diffuses through the stomates, the small openings in the leaves and green stems, and into the manufacturing cells. Two questions arise: (1) under what conditions is the supply of carbon dioxide likely to be the limiting factor in photosynthesis and in growth and development, and (2) has carbon dioxide possibilities for use as a fertilizer? In general, when other factors influencing photosynthesis are in abundant supply, carbon dioxide is the limiting factor. This condition is likely to occur when temperatures are within the optimum range, when the light supply is abundant, and when the plant is supplied with abundant water and fertilizer materials.

About thirty years ago, experiments at the University of Vermont showed that an enrichment of the air with carbon dioxide increased plant growth. In one experiment, cucumbers supplied with air consisting of 31 parts of carbon dioxide in 10,000 parts by volume increased 60 per cent in dry weight over those supplied with 3 parts of this gas in 10,000 parts, the usual concentration. In another test, Irish potatoes, tomatoes, beets, and carrots showed significant increases in growth. In general, increases in the concentration of carbon dioxide from 0.03 per cent to 0.3 per cent by volume have increased the rate of photosynthesis when some other factor becomes limiting in growth. At present, the use of carbon dioxide as a fertilizer is in the experimental stage. It is of interest mainly to scientists and to growers of plants in the greenhouse. Someday, perhaps in the none too distant future, farmers in the United States and elsewhere may use carbon dioxide as a commercial fertilizer.

Water supplies hydrogen and oxygen in the formation of all organic compounds which contain these elements. Its source is the capillary water of soils. This capillary water enters the plant in the root-hair zone and is carried through the xylem and finally to the manufacturing cells. In addition to supplying hydrogen and oxygen in photosynthesis, water has other roles in plant life. An important role is the maintenance of turgor in the guard cells of the leaves. The sausage-shaped guard cells are part of the epidermis or outer tissue of the food making structures and they surround a tiny opening or pore, technically called stoma. In general, when the rate of absorption of water is the same as, or slightly greater than, the rate of transpiration, the guard cells are fully stretched, the little pores are

[1] The author is indebted to the Blakiston Company, Philadelphia, Pa., for permission to use certain information in *Fundamentals of Horticulture*, The Blakiston Company, 1951, in the preparation of this paper.

open, and, as a result, carbon dioxide enters for the manufacture of food. If, however, the rate of absorption of water is less than the rate of transpiration, a chain of events is initiated which results in a low rate of photosynthesis, low growth and yield. The guard cells decrease in size, the stomates close, the diffusion of carbon dioxide into the plant is limited, photosynthesis is reduced and growth is accordingly reduced. This explains why yields of garden crops are low when they are grown in nonirrigated soils during periods of drought.

Raw Materials Used in Commercial Fertilizer Practice

Raw materials used in commercial fertilizer practice are divided into two groups: (1) those which are used in relatively large quantities, the so-called major plant nutrient materials, and (2) those which are used in small quantities, the so-called minor plant nutrient materials.

The Major Raw Materials

The principal raw materials which are used in large quantities are: compounds containing ammonium or nitrate nitrogen; compounds which quickly change to ammonium or nitrate nitrogen; certain phosphates; certain carriers of potassium; and certain compounds of lime.

The ammonium and nitrate carriers supply nitrogen. Nitrogen enters into the formation of all proteins; proteins in turn enter into the formation of protoplasm; and when a plant is making new protoplasm, it is making new cells. It follows, therefore, that with other factors favorable for growth, the available nitrogen supply determines the rate at which new cells are made and the rate at which sugars are used. If, for example, a plant has a high rate of photosynthesis and absorbs *large* quantities of available nitrogen, and is subjected to temperatures within the upper half of the optimum range, the sugars are used almost entirely for the production of stems, leaves, and absorbing roots. If, on the other hand, the plant has a high rate of photosynthesis and absorbs *moderately* large quantities of available nitrogen, and is subjected to temperatures within the upper half of the optimum range, the development of stems and leaves is less rapid, and, as a result, there is less rapid utilization of sugars for stem, leaf and root growth. Some sugars are left for the development of flower forming substances and flowers, fruit and seed. Thus, with other factors in favorable supply, the amount of available nitrogen regulates the rate of new cell formation and the rate of growth to a marked degree. In general, farmers and gardeners have found this to be the case.

Symptoms of Nitrogen Deficiency and Excess

Since large quantities or small quantities of available nitrogen may exist in soils, and since the supply is likely to determine the rate of growth, a working knowledge of symptoms of nitrogen deficiency and nitrogen excess is useful. In general, symptoms of nitrogen deficiency vary with the two great groups of plants: the monocots and the dicots. With monocots the leaves become yellow at the tips, and the yellowing gradually proceeds down the center while the margins remain green. With dicots the leaves become uniformly light green, then uniformly yellowish green and finally uniformly yellow. In both groups the old leaves show the symptoms first; the stems and leaves of all plants grow slowly; and the stems of herbaceous plants become prematurely stiff and woody.

Symptoms of nitrogen excess apply particularly to crops which are grown for their fruit or seed, such as tomato, pepper, or snap bean, and to crops which are grown for their fleshy vegetative structures, such as onion bulbs, Irish potato tubers, and sweet potato roots. With these crops, nitrogen excess is manifested by extreme vigor of the top and large dark green leaves, and by the suppression or delay of the development of the flowers and fruit or storage organs.

The source of supply of available nitrogen may be placed into two groups: (1) natural and (2) artificial. Natural sources are the proteins of soil organic matter and the nitrogen gas of the atmosphere. Both of these forms are changed to ammonia or nitrates by certain soil organisms. The ammonifiers and nitrifiers change the proteins to ammonia and nitrates, and the nitrogen fixers change the nitrogen gas of the atmosphere to protein nitrogen. These organisms thrive best in warm, moist, well-drained and slightly acid soils. Under these conditions, they make available from 50 to 300 pounds of nitrogen per acre per year. However, despite the amounts which are made by these soil organisms, only in exceptional cases are there sufficient quantities for the satisfactory growth of garden crops. Thus, applications in the form of commercial fertilizers are necessary.

From the standpoint from their effect on soils, nitrogen fertilizers are placed in two groups: (1) those which make soils more acid, and (2) those which make soils less acid. Since, in general, soils for garden crops should be slightly acid to obtain satisfactory growth and yield, the acid-forming properties of nitrogen carriers should be considered. Certain acid and non-acid nitrogen fertilizers are presented in Table 1.

TABLE 1—ACID AND NON-ACID FORMING NITROGEN CARRIERS

Acid-forming carriers	N *per cent*	*Non-acid-forming carriers*	N *per cent*
Ammonium sulphate	21	Sodium nitrate	16
Urea	46	Cyanamide	22
Ammo phos	11	Calcium nitrate	16
Dried blood	13	Ammonium nitrate	32

Phosphorus compounds supply phosphorus. Although the role of phosphorus in plant growth has not been definitely determined, recent investigations indicate that phosphorus is necessary for the formation of high energy compounds in photosynthesis and in respiration. Symptoms of phosphorus deficiency are not as striking as those for nitrogen, potassium, magnesium and other elements. In general, with monocots the growth of

seedling plants is slow and reddish pigments appear in the old leaves. With dicots the young leaves are relatively small and grayish-green or dark green, and the old leaves have yellow or brown spots either on the margins or throughout the entire blade.

Compounds which are used to supply phosphorus are monocalcium phosphate and dicalcium phosphate. To keep these phosphates in an available form, garden soils should be maintained in a slightly acid condition. In very acid soils usually less than *p*H 5.5, the relatively insoluble aluminum and iron phosphate is formed, and in alkaline soils, usually more than *p*H 7.5, the relatively insoluble tricalcium phosphate is formed. Unlike nitrates, superphosphate is readily fixed by soils. Consequently, very little movement or leaching takes place and excessive amounts in the soil solution do not exist. Therefore, phosphates may be applied when convenient and preferably in close proximity to the plant's roots. For most crops, it is usually applied at the time of soil preparation and as side dressing during the early stages of growth.

Potassium carriers supply potassium. Potassium is believed to be part of an enzyme system which changes the sugars to starch, and to be associated with photosynthesis. Leaf blade deficiency symptoms vary with the kind of plant. In general, crop plants may be placed in two groups: (1) the legumes and (2) the non legumes. With the legumes, small pin point white or grayish spots appear just back of the margins. As the deficiency increases, the spots also increase, and finally the entire margin becomes white or gray. With the non legumes the margins turn yellow, the yellowing proceeds between the veins and the margins turn brown or purple. In both groups the old leaves show the symptoms first. In common with phosphates, soils fix potassium compounds. Thus, the potassium carriers may be applied at the time of soil preparation or as a side dressing during the early stages of growth. The principal potassium carriers are potassium chloride and potassium sulphate, both of which contain from 48 to 50 per cent potash.

Substances supplying calcium are the three forms of lime: calcium oxide, calcium hydroxide and calcium carbonate. Although calcium is necessary for the making of new cells, the three forms of lime are used primarily to maintain garden soils in a slightly acid condition. Numerous investigations have shown a definite relation of soil acidity to nutrient availability and plant growth. In very acid soils, usually less than *p*H 5.0, at least four essential elements become either deficient or unavailable. The nitrates become deficient, since the activity of the ammonifying, nitrifying and nitrogen fixing bacteria is markedly reduced; phosphates become unavailable, since the relatively insoluble aluminum or iron phosphate is formed; and calcium and magnesium become deficient, since these elements have been lost through leaching or cropping. In alkaline soils, usually greater than *p*H 7.5, at least six essential elements become deficient or form insoluble compounds. The nitrate supply is low, since here again the activity of the beneficial bacteria is reduced; and phosphorus, potassium, manganese, iron, and boron become deficient, since the carriers of these elements form insoluble compounds. In other words, in slightly acid soils only, nitrogen, phosphorus, potassium, calcium, magnesium and other nutrient elements are likely to be present in sufficient quantities for the rapid growth of garden crops.

The Minor Raw Materials

The principal raw materials which are used in small quantities are compounds supplying magnesium, manganese, iron, and boron. Substances supplying magnesium, manganese, and iron are dolomitic limestone, magnesium sulfate, manganese sulfate and ferrous sulfate. Magnesium, manganese and iron are necessary for chlorophyll formation. Magnesium is the center of the chlorophyll molecule, and manganese and iron are catalysts in chlorophyll formation. Leaf blade deficiency symptoms of each of these elements are quite similar. In general, the tissue between the veins changes from dark green to light green and from light green to yellowish green while the veins remain green. With magnesium deficiency, the old leaves show the symptoms first, while with manganese or iron deficiency, the young leaves show the symptoms first.

Substances supplying boron are boric acid and borax. Of these, borax is the more widely used. Although the role of boron is in the theoretical stage, symptoms of boron deficiency are rather well-known. In general, the terminal and lateral buds fail to develop; young leaves become small and lopsided; and the flesh of storage structures such as fleshy roots, cauliflower and cabbage heads become dark and bitter. In common with other plants, garden crops require boron in very small concentration, usually from 0.1 to 1.0 p.p.m. in the soil solution. If the concentration exceeds 1 p.p.m., harmful effects are likely to occur. In general, garden crops require from 10 to 20 pounds of boron per acre or from ½ ounce to one ounce per 100 square feet of garden space.

Principles of Commercial Fertilizer Practice

The principles of commercial fertilizer practice revolve around three questions: (1) what commercial fertilizer should be selected, (2) when should the commercial fertilizer be applied, and (3) when and how should the commercial fertilizer be placed.

The selection of a suitable fertilizer depends largely on (1) the fertility level of the soil, (2) the type of growth desired, and (3) the season of the year. As is well-known, garden soils vary in fertility. This variation is due chiefly to the texture and to the organic matter content of the soil. These factors in turn determine the relative proportion of nitrogen to phosphorus and potassium in the mixture. In general, mixtures high in nitrogen to phosphorus and potassium are likely to give satisfactory results under the following conditions: (1) where the soil contains only small quantities of organic matter, (2) where the top soil is sandy or gravelly in texture, and (3) when the top soil has been removed by erosion or covered by the grading operation. Conversely, mixtures comparatively low in nitrogen in proportion to phosphorus and

(Continued on Page 112)

Wood Waste, An Undeveloped Resource

• By Elwin E. Harris, Ph.D., *(University of Minnesota)*
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America is still wasteful of its wood. It leaves enormous amounts of usable wood products in the forest. It does not to the fullest extent now possible utilize the byproducts of wood processing.

This important article points out the qualities that make wood available. It studies its structure, and explains how wood can be turned into simple sugars suitable for human consumption, for feeding animals, for fermenting into alcohol and other products, and for the production of yeast as food.

Many different concepts exist as to what constitutes wood waste.

From the point of view of the greatest conservation of our nation's resources, one must consider as waste any part of a tree that is not converted to its highest use. By this definition, tops of trees, long butts, and cull timber left in the woods, and mill residues in the form of slabs, shavings, and sawdust, some of which are used at the mill as fuel, are waste. Timber killed by fire or insects and left in the woods to rot is waste. Wood used for a purpose lower than its quality warrants is waste. Water-soluble products lost in the pulping of wood and alkali-soluble products lost in the manufacture of rayon from wood pulp are waste. The present status of knowledge on the uses for waste is not sufficient to provide profitable uses for all wood now wasted, but the potentiality is there, and research, with changes in economic conditions, will provide the way.

Compared to other products, wood has several characteristic properties which can be used as the basis for its utilization.

First among these, so far as value is concerned, is beauty. The beauty of the grain of wood is unmatched. Much effort has been exerted to duplicate the grain of wood by photographic processes. It would appear, therefore, that wood with a desirable grain pattern should be used for purposes that will make the most of this beauty and that any less valuable use would be wasteful. The use of high-quality veneer logs for production of construction lumber is thus wasteful.

Cull wood left in the woods to rot.

Other properties of wood make it valuable as lumber. Its strength, its easy workability with ordinary tools, and its ready adaptability for many different needs have made wood a favorite material for construction purposes. In many instances, more wood or better-quality wood is used than is required. Long lengths of wide, high-quality knot-free boards are cut up to make small items that could be cut from low-quality material. Such use is wasteful of high-quality material.

Logging operations each year leave in the woods to rot about 49 million tons of timber as parts of trees. Some of this waste could produce valuable lumber for the construction of houses. Production of lumber and primary wood products at mills result in about 53 million tons of wood annually as waste material. Slab and cull wood from sawmills now disposed of by burning could produce first-quality short pieces for furniture. The total waste from logging and mill operations is over 100 million tons a year. Better operating methods could decrease this waste.

A third characteristic of wood is its fibrous structure. Fibers make wood of value for production of paper and fiberboard. Softwood (needle-leaved trees) like pine and spruce, have longer fibers than hard-woods (broad-leaved trees) and make stronger paper. Both types are used for paper production. Paper and pulp production consumes about 20 million tons of wood annually. This quantity of pulp and paper could be produced from a part of the waste from logging and sawmill operations, and a large residue would still be left

for other uses. Some mills now use such wood for pulp production.

The size and shape of the tree, or the size of the piece that is chipped-up for making paper is of little consequence because all wood is converted to chips in the production of chemical pulp. For production of better-quality pulp, bark is usually removed from the wood before it is chipped. Wood waste may be barked and chipped in the woods and taken to the pulp mill as chips that may be handled mechanically, thereby saving much labor. Logs may be barked before conversion to veneer or lumber, so that all waste from the veneer mill or sawmill may go to the chipper for production of pulp chips. Chips used for production of dark-colored box-board or insulating board and hardboard may be made from wood with some bark.

The fibers of wood contain cellulose that may be dissolved after various treatments and used for production of rayon, cellophane, plastics, lacquers, and explosives. The fibers from which these cellulose derivatives are produced could have been prepared from wood waste, because wood waste, if it is free from bark and rot, contains the same amount of cellulose as wood used for lumber. Hardwoods, such as aspen, beech, and maple, appear to contain a cellulose that is as satisfactory for dissolving purposes as that from softwoods.

Chemically, wood is composed of 45 to 50 per cent of cellulose, 20 to 25 per cent of hemicellulose, 20 to 30 per cent of lignin, and a small amount of extractives. The cellulose and hemicellulose are converted to simple sugars by the action of water and acid. Pure glucose, the sugar obtained from wood cellulose, is also obtained by the action of water and acid on starch from corn or potatoes. Hemicellulose, depending on the type of wood, yields mixtures of simple sugars, such as galactose, mannose, xylose, and arabinose. In the presence

High grade flooring made from sawmill waste.

of strong acids, the cellulose and hemicellulose are converted quantitatively into a 65 to 75 per cent yield of sugars.

Plants using strong acid for converting wood to sugar were operated in Germany for many years but at great expense. About 1934, a dilute-acid process using sulfuric acid of a 0.5 per cent concentration, under a steam pressure of 150 pounds per square inch was developed in Germany and is now in operation. Another plant is in operation in Switzerland. The yield of sugar is about 50 per cent of the weight of the wood. The sugars from either the strong- or dilute-acid process may be crystallized to produce sugars suitable for human consumption or may be left in dissolved form for animal-feeding purposes. They may also be fermented, or treated chemically to produce a great variety of products. Sugars from the dilute-acid process are usually fermented, producing industrial alcohol for motor fuel and chemical uses. Softwoods, such as pine and spruce, yield alcohol equal to about 50 U. S. gallons of 95 per cent alcohol from one ton of wood. During World War II when Germany was short of protein food, a high-protein yeast was grown on the wood sugar. The yield of dry yeast containing 50 per cent of protein was about 50 per cent of the sugar, or 25 per cent of the dry wood.

During World War II, the U. S. Forest Products Laboratory at Madison, Wis., conducted tests on the yield of sugars from various American species of wood and studied uses for these sugars. These tests have been continued since the end of the war. A process was developed that yields about 50 per cent of sugars in 6 to 7 per cent concentration from bark-free wood. The presence of bark decreases the yield of sugar in proportion to the amount of bark present. Sugars from this process were fermented, yielding alcohol equivalent to 60 gallons of 95 per cent ethyl alcohol from 1 ton of dry Douglas-fir sawmill waste.

Sugar solutions from the hydrolysis of many different species of wood were evaporated to a sugar concentration of 50 per cent, the yield being about one ton of solution containing 50 per cent of sugar from one ton of waste. This sugar solution was tested as a supplementary feed for cattle, swine, and poultry by many agricultural experiment stations and found equal to cane molasses in feeding value. Six and one-half gallons of the solution containing 50 per cent of sugar were equivalent to one bushel of corn in carbohydrate feeding value.

Feeding experiments have shown that the addition of a small amount of readily available carbohydrate, such as that present in wood sugar, plus a source of nitrogen, to agricultural residues, straw, corncobs, or oat hulls increases their palatability and digestibility. Cattle have been fattened for market with ground straw or corncobs mixed with 25 per cent, by weight, of a solution containing 50 per cent of sugar and with the necessary amounts of sources of nitrogen. This finding promises a cheaper means of producing beef and milk by using agricultural residues now wasted, as well as a large market for sugars produced from wood. Many beef cattle are grown in timber-producing areas, and

some of these areas have a surplus of straw, but do not have corn.

Another large potential use for concentrated wood-sugar solutions is in the preservation of grass silage. Much farm land, even in the corn belt, is not suited for corn production because of excessive soil erosion. Other areas are not suited for corn because of climatic conditions. Farmers in these areas grow clover and alfalfa for feed. These feeds retain their highest feeding value if preserved green in a silo. Sugar is added to grass silage to insure preservation and increase the carbohydrate feeding value. Concentrated solutions of sugar produced from wood have been found ideal for this purpose in experiments in Wisconsin, Oregon, and Washington.

Wood-sugar solutions may be used as a nutrient for the production of yeast. In the absence of air, yeast produces ethyl alcohol, but if the yeast is supplied air and a source of nitrogen and phosphate, it grows and produces no alcohol. In special equipment designed to mix air with a solution, a wood-sugar solution containing the necessary nutrients is introduced continuously along with air to a culture of yeast. Yeast growth is very rapid, requiring a holding time of only three hours to utilize all the sugars in a 5 per cent solution and produce a 50 per cent yield of dry yeast containing 50 per cent of protein. Yeast produced in this manner was used as human food in Germany during World War II. Approximately 20,000 tons a year were produced. The yeast is a high-quality source of B-complex vitamins, as well as of protein, and may prove to be the most economical source of these vitamins. Feeding tests with protein-starved adult rats have shown that yeast produced on wood sugar contains all the essential amino acids, except methionine, needed to replace protein tissue. When the required amount of synthetic methionine was added to it, the yeast produced the same weight gains as did animal protein.

Experimental work has shown that sugars produced from wood waste may be used for many types of fermentations. The following products have been produced experimentally: butyl alcohol, butyric acid, lactic acid, acetic acid, 2,3-butylene glycol, and glycerine.

Another constituent of wood is lignin. Lignin is composed of condensed aromatic compounds and represents the greatest annually reproducible source of aromatic compounds. The complexity of the lignin molecule has not permitted high yields of usable products in the past, but rapid progress is being made in lignin research. It is expected that very shortly the key will be found to unlock the lignin molecule and provide almost unlimited supplies of aromatic compounds for science and industry.

For many years, wood distillation has provided a means of using cull and waste wood. The yield of products is seldom over 50 per cent and therefore is wasteful of material. The process involves heating wood in the absence of air. The organic compounds in the wood undergo decomposition, leaving a char and giving off volatile products. The char represents about one-third of the original wood. The volatile products contain methanol, acetic acid, and tar acids. The tar acids are largely phenolic and are assumed to have their origin in the lignin. Char from wood is in high demand for metal refining because of its low ash content. Its porous nature gives it high absorbent properties for deodorizing or decolorizing. It burns without a flame or smoke and is favored for use in railroad dining cars and at picnics. Methanol and acetic acid after purification have ready markets, but markets for the tarry products are limited.

Bark, another waste product from trees, has found only limited use. Bark contains tannin. Many of the early tanning processes in the United States depended on tannin from bark. The separation of this bark involved high labor costs, and it became economical to buy tannin from foreign countries. Attempts are being made in some areas of the country to develop mechanical means of handling the bark that may result in lower costs for tannin.

Bark also contains cork. One company in the United States has developed a means for separating the cork from other parts of the bark of Douglas-fir and marketing it for various uses.

Bark contains oils, fats, and waxes. In some trees, the oil, fat, and wax content of bark may be as high as 20 per cent. Proposals have been made to construct a plant to extract oils, fats, and waxes from old-growth Douglas-fir bark, which is especially high in these substances.

Fibers from redwood bark have been found to make a satisfactory insulating material for house construction.

Chemical pulping processes, such as the sulfite and sulfate processes, convert over half of the wood into soluble products. Water-cooking or semichemical processes convert 10 to 25 per cent of the wood into soluble products. In most mills, these soluble products are wasted. In the sulfite process, most of the lignin and about 30 per cent of the carbohydrates are dissolved. About one-third of these carbohydrates, or 10 per cent of the wood, survives the pulping process and remains in the waste pulping liquors as simple sugars. If these sugars are allowed to flow into a body of water, oxygen in the water is rapidly absorbed, leaving insufficient oxygen for fish life in the water. Sulfite liquor thus presents a disposal problem. One pulp mill in Wisconsin uses these sugars to produce yeast. Another in Washington uses the sugars to produce industrial alcohol.

Dissolved lignin in waste liquors from sulfite pulping is being processed by one mill in Wisconsin to yield vanillin, tanning agents, air-entraining agents, and other products.

Dissolved lignin in sulfate-pulping liquors is being recovered by a company in South Carolina for use with rubber and in plastics.

In conclusion: Wood products left in the woods or as a byproduct in the processing of wood could be used to produce lumber products, pulp and paper, container and building board, cellulose derivatives, sugar for food or for production of chemicals, and various products from lignin and bark. ●

Chlorophyll: Trends in Current Therapy

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Everybody is reading about, talking about, and wondering about chlorophyll.

We use it in toothpastes that are supposed to lessen dental caries and sweeten the breath. We take it orally to kill body odors. Physicians apply it to foul-smelling wounds and ulcers. We even add it to dog food to kill dog odors.

Green plants make chlorophyll. Goats eat green plants; yet they are noted for their pungent odor.

What is the truth about chlorophyll?

●

Chlorophyll, the green leaf pigment, and the part that it plays in the conversion of solar energy into chemical energy, have been the subject of extensive research. This conversion, known as photosynthesis, involves the formation of carbohydrates from carbon dioxide, water, inorganic salts, and light. From these carbohydrates and certain other elements the plants synthesize foodstuffs, vitamins, medicines, and many other substances considered necessary to life.

In recent years chlorophyll itself has been found to possess therapeutic value. This review will deal with the pharmaceutical and medicinal application of water-soluble chlorophyll products known as chlorophyllins.

Chlorophyll (*Chloros*-green and *Phyllon*-leaf), the green pigment in leaves, was named by Pelletier and Caventou about 1818. In 1864 Stokes was able to show that chlorophyll is a mixture, and in 1906 two forms now known as chlorophyll "a" and "b" were separated by Tswett. The structure of these two forms is identical except that a methyl group in "a" is replaced by an aldehyde group[1]. In leaves, chlorophyll is localized in microscopic bodies called chloroplasts, which in turn are enclosed in the cytoplasm of the cell. Actually there are two other types of pigments associated with chlorophyll, namely, carotene and xanthophyll[2]. In leaves chlorophyll "a" and "b" occur naturally in a ratio of 3:1, are physically and chemically related, soluble in fat solvents, and insoluble in water.

Chemically, chlorophyll "a" and "b" are magnesium porphyrin complexes bearing two carboxyl groups esterified respectively with phytol and methyl alcohol. Alkaline hydrolysis of the phytyl and methyl esters, and an opening of a ring, result in the formation of water-soluble sodium magnesium chlorophyllin. The magnesium of the chlorophyllin can be replaced by copper, iron, nickel, or other metal producing a light-fast product[1].

The following reactions are involved in the conversion of oil-soluble chlorophyll "a" to water-soluble sodium copper chlorophyllin[3]. Although commercial chlorophyll preparations that are used in the manufacture of water-soluble chlorophyllins contain both the "a" and "b" forms, we shall consider the "a" form in the reactions shown below.

1) Alkaline hydrolysis of the phytyl and methyl esters and an opening of a ring:

$$\underset{\textit{Chlorophyll (water-insoluble)}}{C_{32}H_{30}N_4OMg\begin{matrix}(COOCH_3)\\(COOC_{20}H_{39})\end{matrix}} + 3\ NaOH \rightarrow \underset{\substack{\textit{Sodium magnesium chlorophyllin}\\ \text{(water-soluble)}}}{C_{31}H_{31}N_4Mg(COONa)_3}$$

2) Replacement of magnesium and sodium by hydrogen:

$$\underset{\substack{\textit{Sodium magnesium chlorophyllin}\\ \text{(water-soluble)}}}{C_{31}H_{31}N_4Mg(COONa)_3} + 5\ HCl \rightarrow \underset{\substack{\textit{Chlorin-e}\\ \text{(water-insoluble)}}}{C_{31}H_{31}N_4H_2(COOH)_3}$$

3) Replacement of hydrogen by copper:

$$\underset{\substack{\textit{Chlorin-e}\\ \text{(water-insoluble)}}}{C_{31}H_{31}N_4H_2(COOH)_3} + Cu(CH_3COO)_2 \rightarrow \underset{\substack{\textit{Copper Chlorin-e or}\\ \textit{Copper chlorophyllin}\\ \text{(water-insoluble)}}}{C_{31}H_{31}N_4Cu(COOH)_3}$$

4) Formation of sodium salt:

$$\underset{\substack{\textit{Copper Chlorin-e}\\ \text{(water-insoluble)}}}{C_{31}H_{31}N_4Cu(COOH)_3} + 3NaOH \rightarrow \underset{\substack{\textit{Sodium copper chlorin-e or}\\ \textit{Sodium copper chlorophyllin}\\ \text{(water-soluble)}}}{C_{31}H_{31}N_4Cu(COONa)_3}$$

The type of metal introduced into the molecule determines the use to be made of the chlorophyllin. Potassium may be replaced by sodium, in the preparation of chlorophyllins. Although many plants have been used as a source of the pigment chlorophyll, alfalfa is commonly used in commercial methods. Shearon and Gee have published a comprehensive report on the commercial chromatographic production of chlorophyll[4].

The salts of copper and magnesium chlorophyllins are generally used in pharmaceutical preparations and are currently quoted at approximately $100.00 a pound.

Green plants have been used for medicinal purposes during the centuries. Green leaf poultices were used by North American Indians to treat infected wounds. In the past forty years chlorophyll has been used to treat a variety of ailments including anemia, arteriosclerosis, hypertension, etc.[5]. Chemically, chlorophyll "a" and "b" are related to hemoglobin of the blood, the chief difference being that chlorophyll contains magnesium and hemoglobin contains iron. This similarity between chlorophyll and hemoglobin prompted early researchers to use this green pigment in the treatment of animal and human anemia. Beneficial results have been reported particularly when it was given in combination with iron[5].

In 1943 a new wick type of air deodorizer containing chlorophyll was placed on the market[6].

During the past twelve years there has been an increasing interest in water-soluble chlorophyll* in the treatment of putrefactive wounds, ulcers, lesions, burns, dermatoses, dental ailments, and as an oral and systemic deodorant.

In 1940, Gruskin published a report on 1200 cases of acute and chronic suppurative conditions. Chlorophyll applied locally deodorized the malodorous condition and diminished the suppurative discharge[7]. Smith and Livingston (1945) studied the effect of chlorophyll on experimentally induced lesions in rabbits, rats, guinea pigs, and dogs. They found an accelerated healing in the majority of cases, and also that chlorophyll in combination with penicillin gave better results than chlorophyll alone[8]. Finkle and Levine (1945) used an ointment containing one per cent chlorophyllin, urea, and benzocaine in the treatment of burns and varicose ulcers. They report a reduction in healing time in the treatment of burns[9]. In 1946, Boehm reported that water-soluble derivatives of chlorophyll were superior to previously used agents for the local treatment of leg ulcers. After a few days the ulcers presented a clean granulating surface and all signs of infection disappeared. There was no local irritation or toxicity[10]. In a series of 400 cases Bowers (1947) has reported remarkable results with chlorophyllins in the treatment of malodorous wounds and ulcers at Winter General Hospital. He noted a rapid disappearance of objectionable odor, cessation of pus formation, and cleanliness of wound within two or three days. Patients who had not been receiving the "green medicine" requested its use because they, too, observed the rapid progress after months of drainage and odor. Even U.S.O. show troupers noted the lack of bad odor in the "bone infection" wards[11]. Recently a preparation containing chlorophyll and kaolin has been marketed for use as a medicinal deodorant for colostomy patients.

A water-soluble chlorophyll solution and ointment (i.e. Chloresium-Rystan Company) containing 0.2 per cent and 0.5 per cent chlorophyllins, respectively, have been accepted by the Council on Pharmacy and Chemistry of the American Medical Association and these products have been included in the 1951 *New and Non-Official Remedies*. (NNR). It is reported that water-soluble chlorophyll derivatives applied locally may aid in producing a clean granulating wound base and a condition suitable for the normal repair of tissue, although conclusive evidence is lacking that chlorophyll derivatives stimulate granulation or epithelialization beyond the normal rate of healing. It is further reported that chlorophyll does exert a deodorant effect on foul-smelling chronic lesions, although it does not exert a significant disinfectant action. These two products are used for deodorization, normal tissue repair, and relief of itching in wounds, ulcers, burns, and dermatoses[12].

Present evidence indicates that chlorophyll enhances tissue resistance by an effect on the normal repair mechanism and perhaps the creating of an unfavorable environment for bacterial survival, rather than by any direct action on the bacteria[8].

Chlorophyll administered to human beings and animals either topically, orally, or parenterally, appears to be non-toxic and free of side reactions[7, 9, 10, 13, 14, 15]. One worker has reported a minimal number of cases of itching[16].

Chlorophyllins have been used in the treatment of peptic ulcers. Offenkrantz (1950) used a preparation containing chlorophyll and antacids in an okra base, and reported that fifty-eight patients showed complete healing in from seven to ten weeks without having been subjected to dietary, alcohol, or smoking restrictions, and without limitations on their daily activity[17].

Chlorophyll has been incorporated into dentifrice preparations, and claims have been made for the caries reducing properties of these preparations and also for their beneficial effect in the promotion of healing of certain tissues and the elimination of mouth odors. The claims for the ability of chlorophyll dentifrices to reduce caries is based on the ability of chlorophyll to inhibit the growth of *Lactobacillus acidophilus* and to inhibit proteolysis in the mouth[18]. In a preliminary report the Council on Dental Therapeutics of the American Dental Association and others suggest that a conservative attitude toward the subject be adopted until a more comprehensive examination can be completed[18, 19, 20].

Goldberg (1943), in a report on 300 cases of Vincent's stomatitis, indicates that chlorophyll is almost a specific and the condition clears up in a few days as compared to a few weeks by former methods of treatment. In pyorrhea the results were less dramatic but much better than with previous methods of treatment[13].

* Whenever the term chlorophyll is used, the water-soluble chlorophyll derivatives (chlorophyllins) are intended, the term chlorophyll being used for brevity.

Chlorophyll has been found to be of value in the treatment of certain types of dermatoses, including contact deramtitis and infantile eczema[5].

The fact that water-soluble chlorophyll, orally administered, would reduce body odors was reported by Westcott in 1950. He had been working with these compounds in the treatment of secondary anemia. During the course of his studies he observed that odors of foods and vitamin B-1 usually detectable in the urine, were greatly decreased when the patients were taking specially prepared chlorophyllins. This indication that some change in the metabolism of these odorous compounds was taking place led him to study the effect of chlorophyll on perspiration and breath odors. As a result of these studies he concluded that chlorophyll is non-toxic and that it effectively neutralizes mouth odors, perspiration odors, and many urine odors[21].

Tebrock, in a recent clinical study of 567 cases, reported an effectiveness of 84 per cent in the control of breath and perspiration odor when 200 mgm. of specially prepared chlorophyllins was administered daily. There was less effectiveness in foot and menstrual odor[22].

A large number of preparations containing chlorophyllins in the form of 100 mgm. tablets have been placed on the market for use in the control of body odor.

There have been reports that chlorophyll in tablet form to be used in the oral cavity for relief of odors resulting from foods, beverages, etc., may have produced a mild nausea in a minimal number of cases[24].

Serling reports that chlorophyll fractions given daily, 100 mgm. per twenty-five pounds of body weight, aid in eliminating most objectionable body and mouth odors in dogs within eighteen to twenty-four hours[25]. A well known brand of dog food now incorporates chlorophyllins as a systemic deodorant.

Although breath and body deodorization through use of chlorophyllins has been confirmed by other workers[21, 22, 23, 25, 26], the exact value of chlorophyll in this respect is not known. The method of odor measurement and the use of control groups are not described in all of the reports. It has been stated that many herbivorous animals, including the goat, consume chlorophyll and are noted for their pungent odor[27]. It should be noted that the chlorophyll obtained by these animals is in a form which is insoluble in water and should not be expected to produce the same results obtained in clinical studies with the water-soluble chlorophyllins[1].

One difficulty encountered in deodorant studies is the measurement and standardization of odors. In many clinical tests the Fair-Wells osmoscope has been used to measure odor intensity. Another instrument, the twin-bulb osometer, measures the presence or absence of odors rather than their intensity. Since both of these methods depend upon the operator's sense of smell, evaluation is subjective and therefore difficult[5].

Many new products containing chlorophyll have either been placed on the market or are being market tested. They include a medicinal spray-bomb, mouth washes, tooth pastes, soaps, shampoos, cigarettes, etc.

Many forms and concentrations of chlorophyll have been used in the experimental and clinical studies. Although both oil-soluble and water-soluble chlorophyll are available, the water-soluble chlorophyllins have been used in most of the experiments. Sodium magnesium chlorophyllin and sodium copper chlorophyllin are available commercially in aqueous solutions of 8 per cent and 14 per cent concentration, and in dry granular form of 20, 25, 50, 75, and 90 per cent concentrations. These products are used to prepare pharmaceutical and medicinal preparations.

Since no official chlorophyll preparations or standards of quality and purity are as yet published in the *United States Pharmacopoeia* or in the *National Formulary*, it is difficult to determine the actual amount of chlorophyll present in many of the preparations available for medication. A product that is labelled to contain 100 mgm. of chlorophyll extract per tablet may actually contain anywhere from 8 to 90 mgm. of pure chlorophyll per tablet.

Summary

1) Chlorophyll, applied either orally or topically, appears to be non-toxic and free from side reactions.
2) Chlorophyll orally administered is an aid in controlling breath and body odor in a majority of subjects tested.
3) In the treatment of foul smelling and suppurative wounds the local application of chlorophyll is an aid in the control of odor, the reduction of suppuration, the production of a clean granulating wound base and a condition suitable for the normal repair of tissue.
4) Preliminary evidence indicates that chlorophyll is an aid in the treatment of certain dental ailments, dermatoses, burns, and in the management of peptic ulcers.

It is apparent from a review of the literature that the green pigment is a valuable therapeutic agent. There is need, however, for additional research and clinical studies directed toward an understanding of the mode of action and the exact value of chlorophyll in medication. ●

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(Continued on Page 109)

NEW BOOKS

The Battle for Mental Health

• *By* JAMES CLARK MALONEY, M.D. New York: Philosophical Library. 1951. Pp. x + 105. $3.50.

In eight short chapters and less than one hundred pages Dr. Maloney tries to do too much. He has tackled one of the most disconcerting and startling problems confronting America today, and with dispatch and abandon has attempted to put his finger on the *causa causae* of our mental and emotional troubles.

In keeping with present day writings on child care, the author lays much blame for mental illness upon current obstetrical, pediatric and child-rearing methods. His comparison of present day infant-coddling practices with the aboriginal or primitive methods seem to be more amusing than scientific. He has, nevertheless, effectively shown that much of our mental unbalance is directly due to abnormal associations and tensions which are part of our civilized ways and exist in our culture. Whether the answers to the many problems presented are to be found in better medical practices, more effective pre-natal or post-natal education for parents or in better physical facilities for the care of mothers and babies, does not seem to be developed. In this short treatment, however, the extreme importance of the subject of mental health is indicated as a challenge to our best thinking.

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Psychology in the Service of the School

• *By* M. F. CLEUGH. New York: Philosophical Library. 1951. Pp. VII + 183. $3.75.

One of the most crying needs of contemporary social science is to bridge the gap between what we know and its practical application. Professor M. F. Cleugh in this meaty, thought-provoking, though, at times, confusing, treatise points out the great potentialities for service that psychology offers to the teacher, the social worker, the probation officer and all those interested in promoting child care and development.

In his introduction the author carefully indicates the dangerous tendency toward over-simplification of the subject which has grown out of a widespread interest in and popularization of it. The text throughout stresses the all-importance of keeping the delicate tools of psychological techniques far removed from the dabblings of amateurs. Perhaps the text might well be criticized because of the tendency to keep the application of the principles outlined strictly within the use of a hierarchy of practitioners. In this respect, the author tends to leave confusion in the mind of the reader regarding who should and who should not deal with certain problems of the unadjusted child.

One of the refreshing observations in the text is that there is more sameness among children than difference. And the sameness offers a common spring board from whence may flow many and diverse adjustments in the child's behalf.

Perhaps the best chapter in the book is Chapter III —the meaning of maladjustment. Herein the author subtly points out that the popular supposition that psychological tension is betrayed by physical symptoms need not necessarily be so. He effectively shows that many physical disturbances have other causes than psychological maladjustment.

In the handling of aggressive and regressive reactions of children outside the limits of normality, the text stresses the all-importance of using the aid and direction of Child Guidance Clinics. Indeed, in substance, Dr. Cleugh points out the two attributes of a good teacher as first, ability to recognize a maladjusted child—a problem; second, knowledge and understanding regarding social resources available for making adjustments.

In the allotted space it is impossible to convey a sense of the tremendous amount of effort and reflective thought which have gone into this volume, or to take up the glove over some of its postulates. Withal the work is good, and the optimism contagious regarding the value of applied psychology.

To educational administrators who are becoming increasingly conscious of children who deviate from the normal, the volume will be a useful handbook. It should also interest teachers and parents and be most valuable in the hands of social workers, public health nurses and others working in fields where mental deviates are likely to be reported. Rounding up deviate children is often more difficult than providing for their care.

J. William McGowan

Nutrition for Health

• *By* HOLGER FREDERICK KILANDER. New York: McGraw-Hill Book Co., Inc. 1951. Pp. XVII + 415. $3.00.

This is an attractive book on nutritional education that is designed for either a one-year high school course, or as a unit on nutrition, or for supplementary reading with courses in biology, general science, home economics, and social studies. The non-scientist layman will enjoy it, especially the chapters on food superstitions, digestion, food conservation and sanitation. These topics are considered in the later chapters. Earlier sections study daily dietary allowances, the major groups of nutrients, vitamins, and the planning of meals.

A number of photographic illustrations and drawings add to the attractiveness of the book, and plentiful charts and tables contribute to its instructional value. Every person who studies this book will learn what good food habits are, and he will understand the importance of selecting a well balanced diet.

H. C. M.

Oil for the World

• *By* STEWART SCHACKNE and N. D'ARCY DRAKE. New York: Harper and Brothers. 1952. Pp. 128. $2.50.

This is a beautifully made, splendidly illustrated, well written book of modest size that sketches for the lay reader without scientific background a brief, fact-filled story of Oil. There is information about how petroleum was formed in nature, how man discovers oil and brings it to the surface, how he refines the crude oil and uses its products. The concluding chapters deal with research, the conservation of oil for tomorrow's uses, the transportation of petroleum products, and oil as a business. Interest is stimulated by numerous photographs, maps, charts and diagrams. This book will be well thumbed in the public library. It should find a place on the supplementary reading list of the secondary school.

H. C. M.

A Concise History of Astronomy

• *By* PETER DOIG. New York: Philosophical Library. 1951. Pp. XI + 320. $4.75.

Even a layman will enjoy and be stimulated by this book which is, as its title indicates, a brief history of one of the oldest and most fascinating sciences. Students will find it easy to read, and valuable as a handy reference concerning people and events connected with astronomy. The book's general worth is indicated by the fact that it was written by the Editor of the *Journal of the British Astronomical Association* and carries a laudatory foreword by the Astronomer Royal.

Starting with man's earliest ideas and theories concerning the heavenly bodies, the author traces the changes in man's views as more and more new knowledge was discovered by workers of many nations. All the great astronomers of the days before the 18th century, including Copernicus, Bruno, Kepler, Galileo, Huyghens, Descartes, Newton and many others, receive merited attention. Considerable space is devoted to Herschel and to later workers. The concluding chapters discuss the present state of the science.

H. C. M.

The Cooperative Movement And Some of Its Problems

• *By* PAUL HUBERT CASSELMAN. New York: Philosophical Library. 1952. Pp. XIII + 178. $3.00.

At a time when the present socio-economic system is being studiously questioned in the light of the possible advent of a new and uncertain social order, this small book will be found of great value. It is recommended to those who are seeking to obtain an overall picture of the factors involved in the cooperative movement—particularly to persons looking for an understanding of the field for the first time.

The organization plan of the book substantially leads the reader through a fourfold presentation of cooperatives. First, an outline of the ideals and principles of cooperation; second, the organization and promotion of a cooperative economy; third, cooperatives and their relationship to existing socio-economic forces; fourth, the need for cooperatives and the social problems involved.

The text gives a very forthright answer to those who suggest that the cooperative movement is an approach to socialistic control. It aptly points out that the cooperative movement and socialism are poles apart in their generic objectives. The text stresses that the basic principle of the cooperative movement is that of self-help, while the trend in socialized economics is absorption through nationalization.

The foreword by Msgr. M. M. Coady, of St. Francis Xavier University, Antigonish, Nova Scotia, who has contributed more to the cooperative movement than any other living man, is characteristic of Coady's treatment of the subject, and indicates the all-importance of scientific thinking about cooperatives as against superficial enthusiasm and zeal for group action.

Obviously, only the larger aspects of the subject can be covered in an outline such as this. The author, however, has included a most comprehensive bibliography which should enable the reader to satisfy a desire for detailed information concerning any of the phases of cooperation mentioned in the book.

The author's style makes for facile reading and is easy to understand. The book should command a wide acceptance.

J. William McGowan

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Introductory Research

(Continued from Page 78)

ment of the problem; C, *Proposed plan to solve the problem;* D, *A description of the work done;* E, *The answer, or partial answer, to the problem;* F, *Conclusions* (Statements on the usefulness of the results obtained. Prediction of new problems based on these results. Work remaining to be done to solve the original problem.)

A very important adjunct to this course was the requirement that the student become thoroughly familiar with at least one technical journal article describing original work allied to his own problem. The article must be a difficult one; those appearing in the *Journal of the American Chemical Society* are excellent for this purpose. The student's detailed abstract of this article is incorporated in his thesis. Students fulfilling this requirement find to their surprise that they have not yet learned to read. We hope that this requirement does help them to learn to read. Their abstract of the selected article is compared with the original and severely criticized, and therefore rewritten several times, before acceptance.

Each student uses a bound notebook for recording the progress of the work done. The usual requirements for numbered pages, dates, signatures of experimenter and witness, no erasures, initialling of corrections, all entries in ink, table of contents, titling of each page, entering remarks about secondary and seemingly unimportant details, etc., are maintained. Each notebook is examined weekly during the hour set aside for an informal classroom discussion of the work of the group.

The reader has probably by this time raised a few questions. It is difficult to get the students started

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on their work. However, once they are started they generate their own interest as long as the teacher remains enthusiastic and lends a helping hand upon occasion. To get them started, we have found, requires that a few simple experiments be outlined in a conference between student and teacher and that the teacher make sure that the results are encouraging, or at least looked at in an encouraging manner. Once his own enthusiasm is initiated, the student plans his library search and carries it out, frequently returning to the laboratory to avoid ennui resulting from two or three successive afternoons spent in the library. Along about Thanksgiving or Christmas, the full scale project can be planned and the student allowed to guide himself with less help than formerly.

Ideas for these projects come from many sources, as already intimated, because this is "research," not RESEARCH. We are only secondarily interested in winning the Nobel prize. Many worth while projects can be devised by repetition of original work already described in the literature. The student learns just as much (after all, the problem is new to him) and in addition, a much larger variety of suggested projects can be presented for selection than is the case when the teacher's own research interests comprise the list of suggested projects.

The financing of the course has not presented insurmountable difficulties here. Each student is charged a laboratory fee of $15.00 per semester and this amount almost pays for the cost of supplies for the course. We economized by requiring that whenever possible a desired piece of apparatus be built instead of purchased. This, of course, slows down the pace of the work considerably; but it has the far greater advantage of teaching the student how to construct a complex apparatus. They acquired, collectively, not individually, facility in glass blowing, electronic circuitry, carpentry, plumbing, and other useful techniques.

In summation, this introductory research course has helped science by giving the student a much clearer understanding of the meaning of science. It has helped the student by teaching him techniques, facts, and viewpoints that could be acquired in no other way. It has helped the teacher learn a little more about interesting research problems that he would not otherwise have studied so thoroughly; and it has helped the teacher evaluate the character, particularly the qualities of logical thinking and initiative, of his students.

There remain two statements, placed here because of their fundamental importance. If these principles are violated, the course would be vitiated: Each student must know why his project is important. Great care must be taken to insure that the student does not become a hack worker grinding out results for the benefit of the reputation of the teacher. ●

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Procedures in Genetics

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virgin females, (2) examination of the progeny, and (3) mating.

In order to isolate virgin females, one must first acquire practice in distinguishing males from females. The abdomen of the female is fairly broad and its tip is crossed with small lines; the male's abdomen is slightly thinner with a black tip. Secondly, one must remove some or all of the pupae of a generation 7 days after mating and place them in separate vials. This is the only reliable technique since the adults can mate soon after emergence.

Examination of these active insects necessitates the use of an anesthetic. Ether is commonly used. It is applied by means of a cotton tipped wire affixed to the underside of a cork stopper. The unit fits into a vial which forms the anesthetizing chamber. Flies may then be shaken into this chamber, allowed to stand for a minute, and removed onto a piece of paper. Here they are separated into groups of males and females and groups of the traits to be studied, then counted and recorded. If the technique is properly carried through, most of the flies will live and can be used for studies of their genotypes (backcross and testcross).

Each mating must occur in a separate vial or bottle which is labeled with the date and traits of the male and female in question. The parents must be removed on the 10th day, for by the 12th day the progeny will begin to emerge as adults. Counts should then be made each day for the next 10 days and the healthiest separated and mated for continuance of the strain.

For most high school biology courses the use of Drosophila to demonstrate the principles of Genetics would be out of the question. Since the high school biology student does not spend much time in the laboratory, living Drosophila demonstrations would be placed on the instructor's shoulders. Availability of space and sterilization equipment also hinder the employment of this insect.

A suggestion may be made involving the use of preserved Drosophila. If the instructor desires the flies as an aid to teaching, he might run through a number of crosses on his own time preserving the specimens in formaldehyde or alcohol. Thus the flies can be arranged in groups to represent the phenotypic and possibly the genotypic ratios of the various traits. The students could then study, count, and record these various groups and analyze the inheritance. This method would enable the student to at least make observations and mathematical studies of the Drosophila generations. ●

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St. Louis University Institute

(Continued from Page 79)

The seminars in special topics give the students a chance to work out many things for themselves. Classes are divided into groups of six to 12 students. A staff member introduces a topic and attempts to clarify and define its various phases at the first meeting of the seminar. Then the students pursue the topic.

Seminars in the Problems of Teaching Chemistry utilize much of the informality employed in the Special Topics Seminars. Typical problems treated are objectives of elementary chemistry instruction, selection of textbooks, construction of tests, visual aids, and the historical approach to the teaching of chemistry.

The conferences (workshops) are organized for practicing and experienced teachers to get together for one week to discuss their teaching problems. The group organizes itself and selects leaders, formulates the problems to be attacked, and plans its own course of action. The staff of St. Louis University is on hand to provide leadership and expert information, if necessary, but the participants are encouraged to work on their own.

One of the most interesting phases of the whole Institute, which was introduced by the director of the Institute for the Teaching of Chemistry, Dr. Theodore A. Ashford, is the special lecture program. The public is invited to these lectures, given by experts in particular fields, but who direct these lectures toward informing the general public in an entertaining manner. Special lectures for the 1952 session included: W. S. Haldeman of Monmouth College, winner of the 1950 Midwest Award for his "outstanding contributions to the teaching of chemistry"; William E. Morrell, Ph.D., of the University of Illinois; Philip G. Johnson, Ph.D., specialist in Science for the United States Office of Education; and James B. Parsons, Ph.D., of the University of Chicago.

The program leading to the Bachelor of Science degree in the Teaching of Chemistry is given as part of the program of the College of Arts and Sciences and students must meet the requirements of that college for admission.

Those wishing to work toward a Master of Science in the Teaching of Chemistry enroll in the Graduate School. Again, the objective of the graduate degree is not only to confer higher academic and professional degrees but to equip the students with the skill and knowledge necessary to pass on to others their own accumulated information and to add to that knowledge by investigation and research.

To be eligible, students must hold a Bachelor of Science degree with a major in chemistry, and must be recommended by the department from which they received their degree. They should have records satisfactory to the department and hold a high school teaching certificate and have completed the requirements for certificate in the state in which they expect to teach. The courses are set up on the individual basis after the student's adviser determines from his records and certain set requirements what he must do to continue.

Dr. Ashford, and Dr. George W. Schaeffer, head of the Chemistry Department of St. Louis University, are particularly interested in encouraging student activity in professional organizations. Special organizations for the students in chemistry include affiliation with the American Chemical Society; the St. Louis Society of Analysts (a select group of analytical chemists); Sigma Chi Sigma; and the Society of Sigma Xi. Again, on the philosophy of the development of the entire human being and his place in society generally, Dr. Ashford particularly urges the students of chemistry to mingle with the rest of the University's student body in the University's student organizations and special activities.

The Institute for the Teaching of Chemistry was established in 1950. There was virtually no precedent, so revisions have been made after experience proved them necessary. The University has faith that the program as finally developed is a sound one and will prove effective in turning out well-informed teachers of chemistry. In spite of the higher salaries usually paid to research chemists in industry, there are many who prefer teaching. Those teachers, who have learned that "Man does not live by bread alone" and who continue to teach for sheer love of imparting knowledge, deserve special attention and consideration, lest they be lost to the teaching profession, through frustration caused by the unavailability of the training program they need to carry on.

The founders of the Institute believe that the Institute for the Teaching of Chemistry, with its special degree in the noblest of professions, will result in better-trained teachers and better-trained chemists in the future—but even more, in men and women better trained to assume leadership in their schools and community as well-informed, dedicated citizens. The University proudly presents the special program and hopes that it is paving the way so that such a special program will become the rule rather than the exception, particularly in the Catholic colleges and Universities of the nation—and the world. ●

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Chlorophyll Trends

(Continued from Page 103)

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Chinese Chemical Industries

(Continued from Page 87)

red in color. The blackening is produced by rubbing one side of it (the "outside," which alone gets fully black) with canal mud, a process which also produces a more or less shiny surface. The black pigment is ordinary ink, produced by ferric ion in the mud and tannic acid in the sizing, and is deep and brilliant. The result is a cloth which is light and porous enough to be cool, but of sufficiently dense color that one thickness can be worn as a jacket or as trousers.

Some interest attaches to an old recipe for treating a new garment of this cloth so as to increase its durability. This calls for wearing it on a hot day and doing enough work to soak it with perspiration. It is then to be crumpled up and allowed to stand around till it has become moldy. The mold is then rubbed in with lard, after which a good washing with soap and water (to which has been added the juice of boiled garlic) makes the garment ready for routine wear.

When cloth of this kind fails it does so by a cracking, chipping and wearing through of the sizing, and this is supposed to be prevented, or delayed, by the perspiration-mold-fat-soap-garlic treatment as outlined. Until research has been done by modern methods (controlled conditions, comparison with untreated samples, standard measure of amount of wear and of wearing out, etc.) it would be going too far to assert that the treatment actually does have the effect which is claimed. The writer, for one, however, is willing to grant that it may do so, for the question of plasticizing a vegetable gum containing ferric tannate is likely to be a complex one, and to assert that a mold does not elaborate a substance which, with a fat, could have this action would also be going too far. By way of comparison, it now appears that some of the old Chinese medical treatments at which "modern" medicine used to scoff probably have a real action which is less easy to scoff at now that our science has learned of the existence of antibiotics. At least one Chinese herb is known to the writer which has antibiotic activity against at least one organism. It seems quite possible, therefore, not only that new scientific medicines will be found among old herbal remedies, but also that old household tricks in textile and other fields may similarly contain facts and substances which will repay the chemist's attention. ●

ACKNOWLEDGMENTS

1. This material is largely taken from an article by S. K. Hoh, *Lingnan Science Journal*, Vol. 12 Supplement, 57 (1933) from which the drawings and graph are reproduced. C. N. Laird (*Ind. & Eng. Chem.* **10**, 568 [1918]) has also described these potteries. His paper contains some photographs of the processes.
2. The "recipe" mentioned in this section and other details of the dyeing process were obtained from F. A. McClure, *Lingnaam Agricultural Review*, Vol. 4, No. 1 (1927) and from private conversations with Dr. McClure.

Fertilizers in the Garden

(Continued from Page 97)

potassium are likely to give better results: (1) where the top soil is deep, dark in color and contains large quantities of organic matter.

Type of growth relates to the development of stems, leaves and absorbing roots and to the development of flowers, fruit and seed or storage organs. From this standpoint, garden crops may be classified as follows: (1) those which develop their flowers, fruit, or seed or storage organs after they develop their stems, leaves and absorbing roots, and (2) those which develop flowers, fruit and seed, and leaves, stems and roots simultaneously. Examples of the first group are: roses for cut flowers, spinach, lettuce, cabbage, the root crop vegetables, onion, Irish potato, snap bean, and sweet corn. Examples of the second group are: most woody plants, tomato, pepper, okra, cucumber and sweet pea. Because of these differences in type of growth, the nitrogen requirements of these crops differ. In general, plants of the first group require relatively large quantities of available nitrogen during the first or vegetative phase of growth and relatively small quantities during the latter or reproductive phase; whereas, plants of the second group require moderate quantities of available nitrogen throughout the entire growing period.

The season for the year refers primarily to the activity of the ammonifying, nitrifying and nitrogen fixing bacteria in soils. As previously stated, the ammonifiers change the proteins compounds to ammonia; the nitrifiers change the ammonia to nitrates; and the nitrogen fixers take nitrogen directly from the air. Temperatures markedly influence the activity of these beneficial organisms. When the soil is cold or extremely hot, their activity is retarded. Temperatures for their greatest activity are moderately high, in general from 60 to 85 degrees F. Thus, applications of relatively large quantities of available nitrogen are usually necessary in early spring, since the soil has been cold for a considerable time; whereas, applications of relatively small quantities or perhaps none whatever are necessary in early fall, since the soil has been warm throughout the summer.

Time and method of application are determined largely by the behavior of certain fertilizer materials in soils and by the marked influence of nitrogen on plant growth. In general, all fertilizer materials other than certain nitrogen carriers are held in soils. Consequently, they may be applied when convenient, usually at the time of soil preparation, or at the time the nitrogen carrier is applied. In general also, since large quantities of available nitrogen are necessary for the vegetative phase of plant growth, applications of available nitrogen are made just before or immediately after the vegetative phase begins. Thus for woody plants, the trees and shrubs, the nitrogen carriers together with other fertilizer materials are applied just before or as soon as growth of the vegetative buds begin. For herbaceous plants the fertilizers are applied a few days before or at the same time as the seed or plants are planted and supplementary applications are made later.

Commercial fertilizers are applied in various ways. The principal methods are broadcast and side placement. Broadcasting consists of applying the fertilizer evenly over the entire surface of the soil and mixing the material either by hand or by power driven tools within the upper 3-4 inches of soil. In general, this method is used to apply fertilizers to woody plants, the ornamental trees and shrubs of the home grounds and the trees of the home orchards, and to herbaceous plants when they are grown close together as for example: spinach, lettuce, or onion, and to the perennials and annuals of the flower garden. The side placement method consists of applying the fertilizer in a continuous or discontinuous band on one or both sides or on the same level or just below the level of the seed or plants. Many investigations have shown that placing the fertilizer on one side and just below the level of the seed of many vegetable crops produces greater yields than placing the materials below the seed. There are definite reasons for greater yield: (1) the fertilizer is placed sufficiently close to the seed so that the roots of the seedling reach the materials in a relatively short time, (2) losses due to the leaching of nitrates are likely to be reduced, and (3) relatively small quantities of the phosphates, potassium and boron carriers are changed to insoluble or unavailable forms. This is particularly true for soils which are very acid on the one hand and slightly alkaline on the other. ●